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DEC 78 J WOLKOVITCH, R B BRASSELL N62269-77-R-0389

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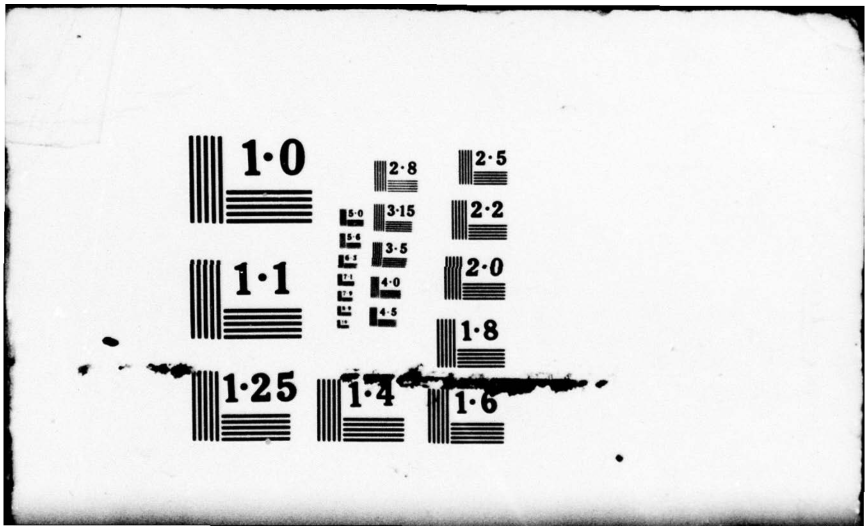
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# VOLAR:A Digital Computer Program for Simulating VSTOL Aircraft Launch and Recovery from Small Ships

## Volume II - Appendices

Julian Wolkovitch
Billy B. Brassell

14 December 1978

Performed for:

NAVAL AIR DEVELOPMENT CENTER
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## Volume II. Appendices.

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A digital computer program has been developed for simulating the launch and recovery of VSTOL aircraft operating from small ships. Volume I of this report describes the program, Volume II is the user's manual. The program, known as VOLAR (Vought Launch and Recovery Dynamics Program), employs the computational technique of nonlinear covariance propagation. This permits the time histories of the means and variances of all system state variables to be computed from a single run, as opposed to the Monte Carlo technique, which requires multiple runs, plus subsequent averaging. Typically, VOLAR requires approximately 7 percent of the computer time required for comparable Monte Carlo simulations.

The program includes a general airframe mathematical model suitable for helicopters or fixed-wing aircraft. The airwake of a small ship is also modeled and ship motion models are included. Two alternative models of the human pilot are supplied, one is based on verbal adjustment rules, the other is based on optimal control theory, utilizing performance index parameters deduced from manned simulator experiments. The program is demonstrated for AV-8A recovery on a small ship. The trends predicted by VOLAR are shown to agree with flight test data.

# FOREWORD

The work described in this report was sponsored by the Flight Dynamics Branch of Air Vehicle Technology Department of the Naval Air Development Center. Mr. Ronald L. Nave served as project engineer and technical monitor for the Naval Air Development Center Mr. Carmen J. Mazza was NADC program manager.

The authors wish to thank the following individuals for their prompt response to requests for technical data: Mr. R. L. Nave; Lt/Col. J. D. Dillow; Mr. R. O. Anderson, Mr. S. J. Craig, and Dr. V. J. Lebacqz. Thanks are also due to Mr. R. L. Fortenbaugh who developed the ship motion and airwake models, and to Mr. R. B. Hughes and Mr. W. C. Waits who made extensive and valuable contributions to programming the analytic models and developed the COMPASS subroutines.

# SUMMARY

A digital computer program has been developed for simulating the launch and recovery of VSTOL aircraft operating from small ships. The program, known as VOLAR (Vought Launch and Recovery Dynamics Program), employs the computational technique of nonlinear covariance propagation. This permits the time histories of the means and variances of all system state variables to be computed from a single run, as opposed to the Monte Carlo technique, which requires multiple runs, plus subsequent averaging. Typically, VOLAR requires approximately 7 percent of the computer time required for comparable Monte Carlo simulations.

The program includes a general airframe mathematical model suitable for helicopters or fixed-wing aircraft. The airwake of a small ship is also modeled and ship motion models are included. Two alternative models of the human pilot are supplied, one is based on verbal adjustment rules, the other is based on optimal control theory, utilizing performance index parameters deduced from manned simulator experiments. The program is demonstrated for AV-8A recovery on a small ship. The trends predicted by VOLAR are shown to agree with flight test data.

Volume I of this report describes the program, Volume II is the user's manual.

## PARTIAL CONTENTS:

> over

# APPENDIX A

# USER'S MANUAL

# APPENDIX A
# USER'S MANUAL

## A.1 Philosophy

VOLAR is designed to be a useful analytical tool for any task involving covariance propagation. It definitely is not limited or restricted to the examples presented in this user's guide. VOLAR is not a simple routine to learn, but once mastered it provides the familiar user with a powerful analytical tool. The intended user should have knowledge of differential equations, matrix algebra, aerodynamics, modeling, control system analysis and synthesis, and Fortran programming.

VOLAR is a relatively flexible program. The basic structure allows one to tailor the routine to his/her particular need or requirement. Then once a problem is run, the user may select from several types of output; including line printer, printer plots, CalComp plots and punch cards.

The program is written in Fortran IV and COMPASS for CDC 6000 or CYBER series computers. Each COMPASS subroutine has a Fortran equivalent.

The subroutines include many comment statements; and for some users, will serve as their own best user's guide. Great care was taken to program in a simple concise manner. When complex programming appears, the authors felt it was necessary due to speed and/or efficiency considerations.

## A.2 Some Comments on the Use of VOLAR

The user's guide should be regarded as just that - a guide. VOLAR cannot be completely learned from a book. The prospective user must get hands-on experience. It is highly recommended that VOLAR be activated and exercised thoroughly. The two sample problems presented in this document provide a good starting point.

The first step in the learning process is to review the general purpose and function of each subroutine (Section A.3). Next, the user should read Section A.4 which introduces the I and R arrays and then become familiar with the main program, VOLAR, and its options (Section A.5). After this, select one of the sample cases and compare the problem-specific programming (refer to Appendices B and C) in the subroutines (particularly DEQU, PROP, and SETUP) with the general descriptions in Section A.3. The explanation of the input decks in Section A.8 or Section A.9 is next. Following this, activate VOLAR on your system. After running the sample cases, try changing a gain or time constant; CalComp plot a new variable: or change output forms. The important point is; roll up your sleeves and dig in.

## A.3 Description of Subroutines

This section presents a brief description of the subroutines. There are basically two types of subroutines. The first type falls into the broad category of "support". These subroutines perform canned operations (e.g. matrix multiplication, integration, etc.) and do not change from problem to problem. The second type of subroutine is very much problem dependent. Through these subroutines the user tailors VOLAR to model and solve his particular problem. Subroutines requiring user interface are so noted in the descriptions which follow.

ADAMS - This subroutine performs second order Adams integration. It is the simplest of the three integration techniques available to the user. All the integration subroutines are constructed to integrate a set of first order differential equations describing the means and three covariance matrices (three are required when an optimal pilot is used). The calling routine is VOLAR.

AIRWAKE - This subroutine calculates airwake disturbance, means and standard deviations, due to the ship's presence. The programmed equations are from Reference 12. The calling routine is DEQU.

AIRWTBL - The airwake data tables of Reference 12 are contained here in DATA statements. This subroutine is called once by SETUP to construct a case-particular particular ($V_{WOD}$, $\psi_{WOD}$) set of airwake tables to be used by AIRWAKE.

AXIS - This subroutine produces a coordinate axis for CalComp plots. The calling routine is CALPLT.

CALPLT - This is a general purpose CalComp plot routine. The calling program is VOLAR.

DASPLT - This subroutine draws dashed lines on CalComp plots. The calling routine is CALPLT.

DEQU - This subroutine contains the differential equations describing the propagation of the means, the aero data table look ups and open loop control inputs. The reference flight values about which the trajectory is linearized are defined and updated here. DEQU is one of the user defined subroutines. It must be programmed by the user to meet the requirements of his particular application. DEQU is called by SETUP and the integration subroutines ADAMS, RUNGE, and KUTTA.

DESCRIB - This routine calculates single-valued nonlinear describing functions of one variable. TABRD must be called before the first call to DESCRIB. The calling routine for DESCRIB is DEQU.

ELLIPSE - This routine draws a 50 percent probability ellipse on CalComp trajectories. These ellipses can be scaled differently from the trajectory to increase the clarity of presentation. The calling routine is CALPLT.

ERF - This routine evaluates the error function associated with the normal distribution curve. The calling routine is DESCRIB.

KUTTA - One of three integration subroutines. This subroutine performs third order Runge-Kutta integration. The calling program is VOLAR.

MATINV - This subroutine calculates the inverse of a matrix. The calling routine is SOLVR.

MATRIX - This routine handles general matrix operations. The operations include adding two matrices, subtracting two matrices, multiplying two matrices, multiplying one matrix by the transpose of another matrix, matrix transposition, and laying a matrix into another matrix. MATRIX is programmed in COMPASS. The FORTRAN equivalent operations appear as comments in MATRIX. The COMPASS version executes about 20 percent faster than the FORTRAN version. The calling routines are PROP and SOLVR.

MISCAL - This subroutine handles miscellaneous calculations that have no logical place to go. MISCAL is called by VOLAR before the output file is written. This subroutine is user specified.

PRNPLT - This is a general purpose line-printer plot routine. A 7 by 7 inch plot is produced. The calling routine is VOLAR.

PROP - This subroutine contains the matrix differential equation for covariance propagation. The user must define the elements of the F and G matrices in PROP. These matrices define the linearized system equations and are normally composed of several smaller submatrices. PROP is called by SETUP and the integration subroutines ADAMS, RUNGE, and KUTTA.

ROTATE - This subroutine rotates a coordinate system through any angle. The calling routines are CALPLT and ELLIPSE.

RUNGE - This subroutine performs fourth order Runge-Kutta integration. It is the more accurate but most time-consuming of the three integration methods available in VOLAR. The calling program is VOLAR.

SETUP - This subroutine initializes the integrators. Any calculations to be initialized and one-time-only calculations also appear in SETUP. For example, ship scaling factors and wind over deck are calculated here because they are fixed for a given run. Because of its problem dependence, SETUP is user defined. SETUP is called by VOLAR.

SOLVR - This subroutine solves for the steady-state ($t \to \infty$) solution of the matrix Riccati equation. It may be used to initialize the covariance matrix, P, before running a time history. It will not work when more than one covariance matrix (e.g. the optimal pilot model case) is involved. The calling routine is PROP.

TABRD - This subroutine decomposes nonlinear functions into even and odd describing function elements. The inputs to TABRD are a table of independent variables, a table of dependent variables, and the number of variables in the tables. TABRD must be called once for each nonlinear element before DESCRIB can calculate the appropriate describing function. The calling routine is SETUP.

TLU - This routine is used to look up a series of dependent variables. Linear interpolation is used to generate the dependent variables. With one call, several dependent variables can be made available to COMMON provided that all the dependent variable tables are associated with the same independent variable table. The calling subroutines are DEQU and PROP.

VOLAR - This routine is the main program and handles almost all the program input and output through its various options.

## A.4 Description of the I and R Arrays

The I and R arrays contain all the integer and real variables of the program respectively. The I array is equivalenced to the elements of the labeled common, "INTEGER". The R array is equivalenced to elements of blank common. The arrays not only handle the communication between the subroutines but also all of the programs input and output. The I and R arrays are user defined.

### A.4.1 Program Modification

If the user wishes to modify the program, any new variables would be added to the common blocks (I or R arrays). This gives the user the capability of inputting or outputting the variables. The new variables may be added any where within the commons.

### A.4.2 Input and Output through the I and R Arrays

All of the programs input and output were designed around the I and R arrays. Since the I and R arrays (common blocks) have many variables and arrays within them, bookkeeping the variables is difficult. To simply the bookkeeping, the I and R arrays are divided into segments and elements. Each segment is defined by a specific number of elements. The segments are classified by groups of elements which are defined by a collection of simple variables or subscripted variables. The lengths of the segments are specified in the problem initialization phase (A.5.1). The initialization phase actually aligns the commons with the I and R arrays. Care must be taken in setting the lengths of the segments after program modification because the input and output will be malaligned. Figure A.1 is an example of a simple R array. In this example, DTOUT may be referred to as segment 1, element 4. The fifth element of TABV2 is segment 3, element 5. Once the user has established the order of variables in the R array, then each variable may be referred to by its segment number and element number within that segment. This facilitates input/output and simplifies modifications to the program. Understanding the concept of the I and R arrays is extremely important to the use of VOLAR.

```
CØMMØN  TIME, TØ, DTIME, DTØUT, DTØUT2, TMAX
CØMMØN  TABV1(6), TABV2(10)
```

| Variable | Segment No. | Element No. |
|---|---|---|
| TIME | 1 | 1 |
| TØ | 1 | 2 |
| DTIME | 1 | 3 |
| DTØUT | 1 | 4 |
| DTØUT2 | 1 | 5 |
| TMAX | 1 | 6 |
| TABV1 | 2 | 1-6 |
| TABV2 | 3 | 1-10 |

Figure A.1

Appendix E presents the variables in the R and I arrays for the analysis reported in this document.

## A.5 The Main Program (Description of Options)

The program is divided into two input phases. The first phase is program initialization which defines the lengths for the R and I arrays. The second phase is user defined and directs the program through the various program options.

### A.5.1 Program Initialization (Phase I)

Definition of the R and I array lengths are input through the following namelist. The lengths of the segments, defined in the program input, must be compatible with the number of variables in blank and labeled COMMON. The segment lengths allow the main program to bookkeep the absolute location of a variable in COMMON.

| 1 | 2 - 80 |
|---|---|
| | $SEGMNT NSEGI=_____, NSEGR=_____, NPRNT=_____, |

| 1 | 2 - 80 |
|---|---|
| | NI(1)=___,___,___,... |

| 1 | 2 - 80 |
|---|---|
| | NR(1)=___,___,___,... |

| 1 | 2 - 80 |
|---|---|
| | $END |

where:

NSEGI - Number of segments in the I array.

NSEGR - Number of segments in the R array.

NPRNT - Print option to display the segments and elements.
NPRNT = 0 - No print.
NPRNT ≠ 0 - Print.

NI - Array containing the number of elements in each I array segment.

NR - Array containing the number of elements in each R array segment.

NOTE: See paragraph A.5.3.1 for a sample input.

A.5.2 Program Options (Phase II)

The program is divided into 28 options to handle problem execution, input, and output. The definition of the options are as follows:

| Option | Task |
|---|---|
| 1 | Write I and R array I/O instructions on a file. |
| 2 | Store data into the I array and write I array data on a file. |
| 3 | Print data from the I array. |
| 4 | Store data into the R array and write R array data on a file. |
| 5 | Print data from the R array. |
| 6 | Setup the differential equations. |
| 7 | Designate the time history variables from the R array to be written to a file by option 21. |
| 8-9 | Inactive. |
| 10 | Read data from input and generate a file compatible for options 14, 15, 17, or 18. |
| 11 | Store tabulating or punching instructions on a file. The file will be used in option 14 or 15. |
| 12 | Store printer plotter instructions on a file. The file will be used by option 17. |
| 13 | Store CalComp plotter instructions on a file. The file will be used by option 18. |
| 14 | Print the time history output in a tabular form. |
| 15 | Punch cards from the time history output. |
| 16 | Inactive. |
| 17 | Plot the time history output on the printer. |
| 18 | Plot the time history output on a CalComp plotter. |
| 19 | Print the contents of a file in blocked form. |
| 20 | Inactive. |
| 21 | Generate a time history. |
| 22-27 | Inactive. |
| 28 | Store the R array on Tape 28 or retrieve the R array from Tape 28. |

A.5.2.1 Option 1 - Write I and R array I/O instructions on a file

1.

| 1-5 | 6-10 | 11-80 |
|---|---|---|
| NØPT |  | LBLØUT |

2.

| 1-5 |  |
|---|---|
| NLIST |  |

3.

| 1-5 | 6-10 | 11-15 | 16-20 | 21-70 | 71-80 |
|---|---|---|---|---|---|
| I | J | K | L | LABEL | SCALE |

Input the following card if I < 0.

4.

| 1-40 | 41-80 |
|---|---|
| FMTI | FMTØ |

where:

NOPT - Option number (input a 1 for this option). (I5)

LBLØUT - Description of option. (7A10)

NLIST - File where the instructions will be written. (I5)

I - Beginning segment number of the I or R array. (I5)

J - Beginning element number of the I or R array. (I5)

K - Ending segment number of the I or R array. (I5)

L - Ending element number of the I or R array. (I5)

LABEL - Variable names for the elements defined between I,J and K,L. (5A10)

SCALE - Scale factor to be applied to the elements. Default is one. (E10.3)

FMTI - Variable input format. (4A10)

FMTØ - Variable output format (4A10)

NOTE:

1. Multiple sets of cards 3 and 4 may be input.
2. FMTI and FMTØ are input only if I < 0.
3. Option 1 is terminated when a blank card is input for I,J,K,L.
4. See Paragraph A.5.3.2 for a sample input.

A.5.2.2 Option 2 - Store data into the I array

1.

| 1-5 | 6-10 | 11-80 |
|---|---|---|
| NØPT | | LBLØUT |

2.

| 1-5 | 6-10 | 11-15 | |
|---|---|---|---|
| NLIST | NDATA | NPF | |

Input the following cards if NLIST = 5.

3.

| 1-5 | 6-10 | 11-15 | 16-20 | 21-70 | 71-80 |
|---|---|---|---|---|---|
| I | J | K | L | LABEL | SCALE |

Input the following card if I < 0.

4.

| 1-40 | 41-80 |
|---|---|
| FMTI | FMTØ |

5.

| 1-5 | 6-10 | 11-15 | | 76-80 |
|---|---|---|---|---|
| IN(K+I) | IN(K+I+1) | IN(K+I+2) | . . . | IN(J+L) |

where:

NØPT - Option number (input a 2 for this option). (I5)

LBLØUT - Option description. (7A10)

NLIST - File containing input instructions. (I5)

NDATA - File containing I array data. (I5)

NPF - File to be created containing I array data. If NPF = 0, no file is created. (I5)

I - Beginning segment number of the I array. (I5)

J - Beginning element number of the I array. (I5)

K - Ending segment number of the I array. (I5)

L - Ending element number of the I array. (I5)

LABEL - Variable names for the elements defined between I,J and K,L. (5A10)

SCALE - Scale factor to be applied to the elements in the I array between I,J and K,L. (E10.3)

FMTI - Variable input format. (4A10)

FMTØ - Variable output format. (4A10)

IN - I array elements (Default is 16I5 and may be changed to FMTI).

NOTE:

1. Multiple sets of cards 3, 4 and 5 may be input.
2. The format for card 5 may be changed by specifying a negative I on card 3 and inputting the format on card 4.
3. If NLIST and NDATA are not equal to 5, cards 3, 4, and 5 are input from files NLIST and NDATA.
4. Option 2 is terminated when a blank card is input for I,J,K,L.
5. See Paragraph A.5.3.3 for a sample input.

A.5.2.3 Option 3 - Print from the I array

1.

| 1-5 | 6-10 | 11-80 |
|---|---|---|
| NØPT | | LBLØUT |

2.

| 1-5 | |
|---|---|
| NLIST | |

Input the following cards if NLIST = 5.

3.

| 1-5 | 6-10 | 11-15 | 16-20 | 21-70 | 71-80 |
|---|---|---|---|---|---|
| I | J | K | L | LABEL | SCALE |

Input the following card if I < 0.

4.

| 1-40 | |
|---|---|
| FMTØ | |

where:

NØPT - Option number (input a 3 for this option). (I5)

LBLØUT - Option description. (7A10)

NLIST - File where print instructions reside. (I5)

I - Beginning segment number of the I array. (I5)

J - Beginning element number of the I array. (I5)

K - Ending segment number of the I array. (I5)

L - Ending element number of the I array. (I5)

LABEL - Variable names for the elements defined between I,J and K,L. (5A10)

SCALE - Scale factor to be applied to the I array elements between I,J and K,L when printed. Default is one. (E10.3)

FMTØ - Variable output format. (4A10)

NOTE:

1. Multiple sets of cards 3 and 4 may be input.
2. The print format may be changed by specifying a negative I and inputting the format on card 4. The format is maintained until it is reset or another option is specified.
3. The option is terminated when a blank card is input for I,J,K,L.
4. See Paragraph A.5.3.4 for a sample input.

A.5.2.4 Option 4 - Store data into the R array, and write the R array on to a file

1.

| 1-5 | 6-10 | 11-80 |
|---|---|---|
| NØPT | | LBLØUT |

2.

| 1-5 | 6-10 | 11-15 | |
|---|---|---|---|
| NLIST | NDATA | NPF | |

Input the following 2 cards if NLIST = 5.

3.

| 1-5 | 6-10 | 11-15 | 16-20 | 21-70 | 71-80 |
|---|---|---|---|---|---|
| I | J | K | L | LABEL | SCALE |

Input the following card if I < 0.

4.

| 1-40 | 41-80 |
|---|---|
| FMTI | FMTØ |

Input the following card if NDATA = 5.

5.

| 1-10 | 11-20 | 21-30 | | 71-80 |
|---|---|---|---|---|
| R(K+I) | R(K+I+1) | R(K+I+2) | ... | R(J+L) |

where:

NØPT - Option number (input a 4 for this option). (I5)

LBLØUT - Option description. (7A10)

NLIST - File containing input instructions. (I5)

NDATA - File containing R array data. (I5)

NPF - File containing R array data is to be created. If NPF = 0, no file is created. (I5)

I - Beginning segment number of the R array. (I5)

J - Beginning element number of the R array. (I5)

K - Ending segment number of the R array. (I5)

L - Ending element number of the R array. (I5)

LABEL - Variable names for the elements defined between I,J and K,L. (5A10)

SCALE - Scale factor to be applied to the R array elements between I,J and K,L. Default is one. (E10.3)

FMTI - Variable input format. (4A10)

FMTØ - Variable output format. (4A10)

R - R array elements (Default is 8F10.3 and may be changed to FMTI).

NOTE:

1. The format for card 5 may be changed by specifying a negative I on card 3, and inputting the format on card 4. The format is maintained until it is reset or another option is specified.

2. If NLIST and NDATA are not equal to 5, cards 3, 4, and 5 are input from files NLIST and NDATA.

3. Multiple sets of cards 3, 4, and 5 may be input.

4. Option 4 is terminated when a blank card is input for I,J,K,L.

5. See Paragraph A.5.3.5 for a sample input.

A.5.2.5 Option 5 - Print from the R array.

1.

| 1-5 | 6-10 | 11-80 |
|---|---|---|
| NØPT | | LBLØUT |

2.

| 1-5 | |
|---|---|
| NTAP | |

Input the following cards if NTAP = 5.

3.

| 1-5 | 6-10 | 11-15 | 16-20 | 21-70 | 71-80 |
|---|---|---|---|---|---|
| I | J | K | L | LABEL | SCALE |

Input the following card if I < 0.

4.

| 1-40 | |
|---|---|
| FMTØ | |

where:

NØPT - Option number (input a 5 for this option). (I5)

LBLØUT - Option description. (7A10)

NTAP - File where write instructions reside. (I5)

I - Beginning segment number of the R array. (I5)

J - Beginning element number of the R array. (I5)

K - Ending segment number of the R array. (I5)

L - Ending element number of the R array. (I5)

LABEL - Variable names for the elements defined between I,J and K,L. (5A10)

SCALE - Scale factor to be applied to the R array elements when printed. Default is one. (E10.3)

FMTØ - Variable output format. (4A10)

NOTE:

1. If NTAP is not equal to 5, cards 3 and 4 are input from file NTAP.

2. The default print format of (7F14.5) may be changed to FMTØ by specifying a negative I and inputting the new format. The new format remains in effect until reset or a new option is input.

3. Multiple sets of cards 3 and 4 may be input.

4. Option 5 is terminated by inputting a blank card for I,J,K,L.

5. See Paragraph A.5.3.6 for a sample input.

A.5.2.6 Option 6 - Set up differential equations.

This option is composed of five groups of data:

1. Derivative indices.
2. State indices.
3. PDØT and P indices.
4. PEDØT and PE indices.
5. PXDØT and PX indices.

Groups 3, 4, and 5 above must be input in the order specified. Each group of data is composed of cards 2 and 3 below.

1.

| 1-5 | 6-10 | 11-80 |
|---|---|---|
| NØPT | | LBLØUT |

2.

| 1-5 | 6-10 | |
|---|---|---|
| M | N | |

3.

| 1-5 | 6-10 | 11-15 | 16-20 | 21-70 |
|---|---|---|---|---|
| I | J | K | L | LABEL |

where:

NØPT - Option number (input a 6 for this option). (I5)

LBLØUT - Option description. (7A10)

M - The segment number of the I array where the R array location of the differential equation elements will be stored. (I5)

N - The element number of the I array where the R array location of the differential equation elements will be stored. (I5)

I - Beginning segment number of the R array where the differential equation elements will be stored. (I5)

J - Beginning element number of the R array where the differential equation elements will be stored. (I5)

K - Ending segment number of the R array where the differential equation elements will be stored. (I5)

L - Ending segment number of the R array where the differential equation elements will be stored. (I5)

LABEL - Variable names for the elements defined between I,J and K,L. (5A10)

NOTE:

1. Multiple sets of card 3 may be specified.
2. Each group of indices will be terminated when a blank card is specified for I,J,K,L.
3. PDØT and P indices are defined by I,J and K,L respectively.
4. PEDØT and PE indices are defined by I,J and K,L respectively.
5. PXDØT and PX indices are defined by I,J and K,L respectively.
6. See Paragraph A.5.3.7 for a sample input.

### A.5.2.7 Option 7 - Designate the time history variables to be output

1.

| 1-5 | 6-10 | 11-80 |
|---|---|---|
| NØPT | | LBLØUT |

2.

| 1-5 | 6-10 | 11-15 | 16-20 | 21-70 |
|---|---|---|---|---|
| I | J | K | L | LABEL |

where:

NØPT - Option number (input a 7 for this option). (I5)

LBLØUT - Option description. (7A10)

I - Beginning segment number of the R array to be output. (I5)

J - Beginning element number of the R array to be output. (I5)

K - Ending segment number of the R array to be output. (I5)

L - Ending element number of the R array to be output. (I5)

LABEL - Variable names for the elements defined between I,J and K,L. (5A10)

NOTE:

1. Multiple sets of card 2 may be input
2. Option 7 is terminated when a blank card for I,J,K,L is input.
3. See Paragraph A.5.3.8 for a sample input.

A.5.2.8 Option 10 - Read data from input and generate a file compatible for options 14, 15, 17, and 18.

1.

| 1-5 | 6-10 | 11-80 |
|---|---|---|
| NØPT | | LBLØUT |

2.

| 1-5 | |
|---|---|
| NLIST | |

3.

| 1-5 | 6-10 | 11-15 | |
|---|---|---|---|
| K1 | K2 | L | |

Input the following card K1 times.

4.

| 1-10 | 11-20 | 21-30 | | 71-80 |
|---|---|---|---|---|
| RØW(1) | RØW(2) | RØW(3) | . . . | RØW(K2) |

where:

NØPT - Option number (input a10 for the option). (I5)

LBLØUT - Option description. (7A10)

NLIST - File where data is to be written. (I5)

K1 - Number of rows of data. (I5)

K2 - Number of columns of data. (I5)

L - Data Flag (I5)

L = 0 - Number of data points equal to the number of rows.

L ≠ 0 - First data point indicates the number of data points in a floating point number.

RØW - Data point array.

NOTE:

1. See Paragraph A.5.3.9 for a sample input.

A.5.2.9 Option 11 - Store tabulating or punching instructions on a file

A. Cards for tabulating instructions.

1.

| 1-5 | 6-10 | 11-80 |
|---|---|---|
| NØPT | | LBLØUT |

2.

| 1-5 | |
|---|---|
| NLIST | |

3.

| 1-5 | 6-10 | 11-80 |
|---|---|---|
| K1 | | TITLE |

Input the following card K1 times.

4.

| 1-5 | 6-10 | 11-20 | 21-70 | 71-80 |
|---|---|---|---|---|
| NTAP | K2 | L | LABEL | SCALE |

B. Cards for punching instructions.

1.

| 1-5 | 6-10 | 11-80 |
|---|---|---|
| NØPT | | LBLØUT |

2.

| 1-5 | 6-10 | |
|---|---|---|
| NLIST | I | |

3.

| 1-5 | 6-10 | 11-20 | 21-70 | 71-80 |
|---|---|---|---|---|
| NTAP | K2 | L | LABEL | SCALE |

where:

NØPT - Option number (input an 11 for this option). (I5)

LBLØUT - Option description. (7A10)

NLIST - File where instructions will be written. (I5)

I - Punching instruction flag. (I5)

I = 0 - Tabulating instruction.

I ≠ 0 - Punching instruction.

K1 - Number of columns for tabulated data (Maximum = 10). (I5)

TITLE - Title for tabulated data. (7A10)

NTAP - File where the instructions will reside. (I5)

K2 - Data column to be tabulated or punched. (I5)

L - Column heading. (A10)

LABEL - Variable description. (5A10)

SCALE - Scale factor to be applied to the data (Default-1.0). (E10.3)

NOTE:

1. K2 is the sequential number for the variable as ordered in option 7.
2. For tabulating instructions, multiple sets of cards 3 and 4 may be input. The option is terminated when a blank card is input for K1.
3. For punching instructions, a multiple set of card 3 may be input. The option is terminated wher a blank card for NTAP and K2 is input.
4. The file NLIST will be used in option 14 or 15.
5. See Paragraph A.5.3.10 for a sample input.

A.5.2.10 Option 12 - Store printer plot instructions on a file.

1.

| 1-5 | 6-10 | 11-80 |
|---|---|---|
| NØPT | | LBLØUT |

2.

| 1-5 | |
|---|---|
| NLIST | |

3.

| 1-5 | |
|---|---|
| K1 | |

Input the following cards K1 times.

4.

| 1-80 |
|---|
| TITLE |

5.

| 1-80 |
|---|
| TITLE |

6.

| 1-80 |
|---|
| TITLE |

7.

| 1-5 | 6-10 | 11-20 | 21-30 | 31-40 | 41-50 | 51-60 | 61-70 |
|---|---|---|---|---|---|---|---|
| NCURVS | | XPLØT | YPLØT | DELX | DELY | STARTX | STARTY |

8.

| 1-40 | 41-80 |
|---|---|
| FMTI | FMTØ |

Input the following cards NCURVS times.

9.

| 1-40 | 41-45 | 46-50 | 51-55 | 56-57 | 58 | 59-60 | 61-70 | 71-80 |
|---|---|---|---|---|---|---|---|---|
| LABEL | NDATA | NCØLX | NCØLY | | NSYM | | SCALEX | SCALEY |

where:

| | | | |
|---|---|---|---|
| NØPT | - | Option number (input a 12 for this option). | (I5) |
| LBLØUT | - | Option description. | (7A10) |
| NLIST | - | File where instructions will be written. | (I5) |
| K1 | - | Number of plots. | (I5) |
| TITLE | - | Three card plot title. | (8A10) |
| NCURVS | - | Number of curves per plot. | (I5) |
| XPLØT | - | Number of inches from left paper margin to the left end of the X axis. | (F10.3) |
| YPLØT | - | Number of inches from top of the paper to the bottom of the Y axis. | (F10.3) |
| DELX | - | Increment per inch on the X axis. | (F10.3) |
| DELY | - | Increment per inch on the Y axis. | (F10.3) |
| STARTX | - | X value at axis intersection. | (F10.3) |
| STARTY | - | Y value at axis intersection. | (F10.3) |
| FMTI | - | Label on X axis. | (4A10) |
| FMTØ | - | Label on Y axis. | (4A10) |
| LABEL | - | Legend associated with a curve. | (4A10) |
| NDATA | - | File where data for the curve is located. | (I5) |
| NCØLX | - | Column number on the file where the X data is located. | (I5) |
| NCØLY | - | Column number on the file where the Y data is located. | (I5) |
| NSYM | - | Plotting symbol. | (A1) |
| SCALEX | - | Scale factor to be applied to the X data (Default = 1.0). | (F10.3) |
| SCALEY | - | Scale factor to be applied to the Y data (Default = 1.0). | (F10.3) |

NOTE:

1. See Paragraph A.5.3.11 for a sample input.

### A.5.2.11 Option 13 - Store CalComp plotting instructions on a file

1.

| 1-5 | 6-10 | 11-80 |
|---|---|---|
| NØPT | | LBLØUT |

2.

| 1-5 | |
|---|---|
| NLIST | |

3.

| 1-10 | 11-20 | |
|---|---|---|
| PCØDE | NTAP | |

4.

| 1-5 | 6-10 | 11-15 | |
|---|---|---|---|
| K1 | | L | |

Input the following cards K1 times.

5.

| 1 | 2-80 |
|---|---|
| | $PLØTD NCURVS=____,ANGLE=____,XPLOT=____, |

6.

| 1 | 2-80 |
|---|---|
| | YPLØT=____, XEXIT=____, YEXIT=____, XLEGND=____, |

7.

| 1 | 2-80 |
|---|---|
| | YLEGND=____, XØRG=____, YØRG=____, LNGTHX=____, |

8.

| 1 | 2-80 |
|---|---|
| | LNGTHY=____, STARTX=____, STARTY=____, DELX=____, |

9.

| 1 | 2-80 |
|---|---|
| | DELY=____, ISØPT=____$END |

Input the following four cards if bit zero of ISØPT is one.

10.

| 1-80 |
|---|
| TITLE |

11.

| 1-80 |
|---|
| TITLE |

12.

| 1-80 |
|---|
| TITLE |

13.

| 1-80 |
|---|
| TITLE |

Input the following card if bit one of ISØPT is one.

14.

| 1-40 | |
|---|---|
| LABELX | |

Input the following card if bit two of ISØPT is one.

15.

| 1-40 | |
|---|---|
| LABELY | |

Input the following card if bit three of ISØPT is one.

16.

| 1-40 | |
|---|---|
| LEGEND | |

Input the next five cards if bit four of ISØPT is one.

17.

| 1-10 | 11-20 | |
|---|---|---|
| X | Y | |

18.

| 1-80 |
|---|
| TITLE |

19.

| 1-80 |
|---|
| TITLE |

20.

| 1-80 |
|---|
| TITLE |

21.

| 1-80 |
|---|
| TITLE |

Input the following cards NCURVS times.

22.

| 1 | 2-80 |
|---|---|
| | $CURVE NDATA=____, NCØLX=____, NCØLY=____, NCX=____, |

23.

| 1 | 2-80 |
|---|---|
| | NCY=____, NCXY=____, LINTYP=____, DASH=____, |

24.

| 1 | 2-80 |
|---|---|
| | NSYM=____, SCALEX=____, SCALEY=____, SCALXX=____, |

25.

| 1 | 2-80 |
|---|---|
| | SCALYY=____ $END |

26.

| 1-6 | 7-10 | 11-50 | |
|---|---|---|---|
| K | | LABEL | |

where:

| | | | |
|---|---|---|---|
| NØPT | - | Option number (input a 13 for this option). | (I5) |
| LBLØUT | - | Option description. | (7A10) |
| PCØDE | - | CalComp plot code. | (A10) |
| NTAP | - | File produced by CalComp. | (A10) |
| NLIST | - | File where plotting instructions will be written. | (I5) |
| K1 | - | Number of plots to be produced. | (I5) |
| L | - | Indicator for plotting on centimeter paper. L = "C.M." | (A4) |
| NCURVS | - | Number of curves per plot | |

ANGLE - Plot rotation angle in degrees (0 or 90 degrees).

XPLØT - Distance in inches for which the origin of the plot is to be moved in the X direction.

YPLØT - Distance in inches for which the origin of the plot is to be moved in the Y direction.

XEXIT - Final pen movement in the X direction.

YEXIT - Final pen movement in the Y direction.

XLEGND - X coordinate of the plot legend in inches.

YLEGND - Y coordinate of the plot legend in inches.

XØRG - X value at which axes intercept.

YØRG - Y value at which axes intercept.

LNGTHX - Length of X axis in inches.

LNGTHY - Length of Y axis in inches.

STARTX - Initial value on the X axis.

STARTY - Initial value on the Y axis.

DELX - Increment per inch on the X axis.

DELY - Increment per inch on the Y axis.

ISØPT - Bit array for read option. See Figure A.4.

BIT(0) = 1 - Read title to be centered over plot.
BIT(1) = 1 - Read X axis label.
BIT(2) = 1 - Read Y axis label.
BIT(3) = 1 - Read legend title.
BIT(4) = 1 - Read coordinates of the title and the title.

TITLE - Four card title. (8A10)

LABELX - X axis label. (4A10)

LABELY - Y axis label. (4A10)

LEGEND - Legend for the curve. (4A10)

X - X coordinate for the title. (F10.3)

Y - Y coordinate for the title. (F10.3)

NDATA - File where data to be plotted is located.

NCØLX - Column number on the file where the X data is located.

NCØLY - Column number on the file where the Y data is located.

NCX - Column number where the X elliptical axis data is located.

NCY - Column number where the Y elliptical axis data is located.

LINTYP - Line type for plot.

LINTYP = Zero, line only (no symbol)

LINTYP = Negative, symbol only (no line)

LINTYP = Positive, both line and symbol

DASH - Length of plotting segments for dashed line in inches. See Table A.1.

NSYM - CalComp symbol code (99 if ellipse).

SCALEX - Scale factor for the X data (Default = 1.0).

SCALEY - Scale factor for the Y data (Default = 1.0).

SCALXX - Scale factor for the X elliptical axis (Default = SCALEX).

SCALYY - Scale factor for the Y elliptical axis (Default = SCALEY).

K - Line style. See Table A.1. (Ø6)

LABEL - Legend for line style. (4A10)

NOTE:

1. See Paragraph A.5.3.12 for a sample input.
2. See Figure A.3 for a plot of ellipses of probability.
3. See Figure A.2 for a diagram of plotting variables.

Table A.1

| LINE | LSTYLE | DASH |
|---|---|---|
| -·-·-·-·-·-·-·- | 177610 | .01 |
| ——— - — | 177610 | .05 |
| -·-----·------ | 177430 | .01 |
| ——— — — | 177430 | .05 |
| -------------- | 177070 | .01 |
| ——— — — | 177070 | .05 |
| ————————— | 177774 | .01 |
| ——————— — | 177774 | .05 |
| - - - - - - - - | 177400 | .01 |
| ———      — | 177400 | .05 |
| ————————— | 177752 | .01 |
| ————- - — | 177752 | .05 |
| ————————— | 177714 | .01 |
| ———— — — | 177714 | .05 |
| ————————— | 125452 | .01 |
| ---- ----- | 125452 | .05 |
| -------------- | 170360 | .01 |
| —  —  — | 170360 | .05 |
| ————————— | 177744 | .01 |
| ———— - — | 177744 | .05 |
| ————————— | 177444 | .01 |
| ——— - - — | 177444 | .05 |
| ————————— | 146314 | .01 |
| - - - - - - - | 146314 | .05 |
| ————————— | 176314 | .01 |
| ——- - - — | 176314 | .05 |
| ————————— | 177777 | ANY |

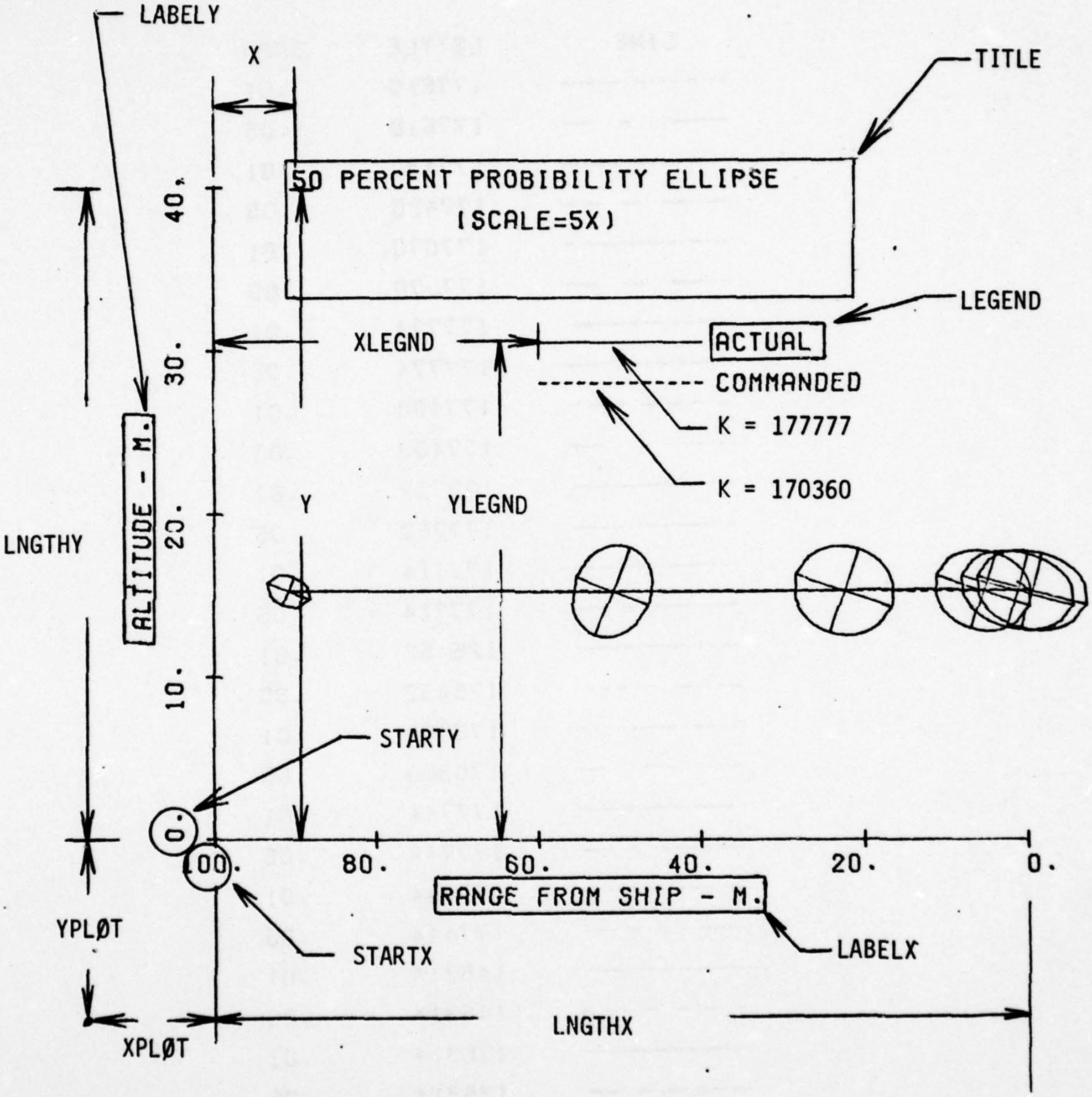

LABELY
X
TITLE
50 PERCENT PROBIBILITY ELLIPSE
(SCALE=5X)
LEGEND
40.
30.
XLEGND
ACTUAL
COMMANDED
K = 177777
K = 170360
ALTITUDE - M.
20.
Y
YLEGND
LNGTHY
10.
STARTY
0.
100.
80.
60.
40.
20.
0.
RANGE FROM SHIP - M.
YPLØT
STARTX
LABELX
LNGTHX
XPLØT

Figure A.2

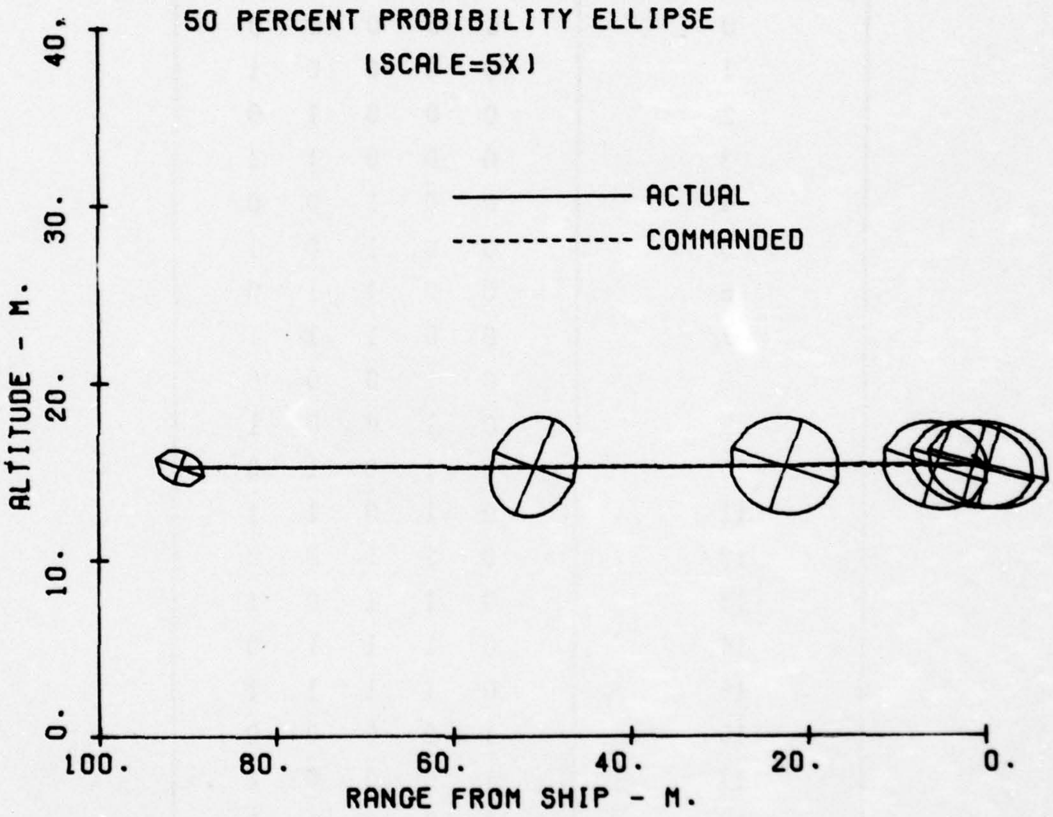


Figure A.3 Example of Probability Ellipses

| 60 BITS/WORD | |
|---|---|
| BITS 59 - 6 | BITS 5 - 0 |

| BIT # | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|
| VALUE | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |

| ISØPT | BIT PATTERN |
|---|---|
| 0 | 0 0 0 0 0 |
| 1 | 0 0 0 0 1 |
| 2 | 0 0 0 1 0 |
| 3 | 0 0 0 1 1 |
| 4 | 0 0 1 0 0 |
| 5 | 0 0 1 0 1 |
| 6 | 0 0 1 1 0 |
| 7 | 0 0 1 1 1 |
| 8 | 0 1 0 0 0 |
| 9 | 0 1 0 0 1 |
| 10 | 0 1 0 1 0 |
| 11 | 0 1 0 1 1 |
| 12 | 0 1 1 0 0 |
| 13 | 0 1 1 0 1 |
| 14 | 0 1 1 1 0 |
| 15 | 0 1 1 1 1 |
| 16 | 1 0 0 0 0 |
| 17 | 1 0 0 0 1 |
| 18 | 1 0 0 1 0 |
| 19 | 1 0 0 1 1 |
| 20 | 1 0 1 0 0 |
| 21 | 1 0 1 0 1 |
| 22 | 1 0 1 1 0 |

Figure A.4

A.5.2.12 Option 14 - Print the time history in a tabular form

1.

| 1-5 | 6-10 | 11-80 |
|---|---|---|
| NØPT | | LBLØUT |

2.

| 1-5 | |
|---|---|
| NLIST | |

where:

NØPT - Option number (input a 14 for this option). (I5)

LBLØUT - Option description. (7A10)

NLIST - File where tabulating instructions are located. (I5)

NOTE:

1. File NLIST is generated by option 11.
2. See Paragraph A.5.3.13 for a sample input.

A.5.2.13 Option 15 - Punch the time history

1.

| 1-5 | 6-10 | 11-80 |
|---|---|---|
| NØPT | | LBLØUT |

2.

| 1-5 | |
|---|---|
| NLIST | |

where:

NØPT - Option number (input a 15 for this option). (I5)

LBLØUT - Option description. (7A10)

NLIST - File where the punching instructions are located (I5)

NOTE:

1. File NLIST is generated by Option 11.

2. See Paragraph A.5.3.14 for a sample input.

### A.5.2.14 Option 17 - Produce a printer plot of the time history

1.

| 1-5 | 6-10 | 11-80 |
|---|---|---|
| NØPT | | LBLØUT |

2.

| 1-5 | 6-10 | |
|---|---|---|
| NLIST | NPRNT | |

Input the following cards if NLIST = 5.

3.

| 1-5 | |
|---|---|
| NPLØTS | |

Input the following cards NPLØTS times.

4.

| 1-80 |
|---|
| TITLE |

5.

| 1-80 |
|---|
| TITLE |

6.

| 1-80 |
|---|
| TITLE |

7.

| 1-5 | 6-10 | 11-20 | 21-30 | 31-40 | 41-50 | 51-60 | 61-70 |
|---|---|---|---|---|---|---|---|
| NCURVS | | XØRG | YØRG | DELX | DELY | STARTX | STARTY |

8.

| 1-40 | 41-80 |
|---|---|
| LABELX | LABELY |

Input the following card NCURVS times.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 9. | 1-40 | 41-45 | 46-50 | 51-55 | 56-57 | 58 | 59-60 | 61-70 | 71-80 |
| | LEGEND | NDATA | NCØLX | NCØLY | | ISYM | | SCALEX | SCALEY |

where:

NØPT - Option number (input a 17 for this option). (I5)

LBLØUT - Option description. (7A10)

NLIST - File where the plotting instructions are located. (I5)

NPRNT - Print option to display input. (I5)

NPRNT = 0 - no print

NPRNT = 1 - print

NPLØTS - Number of plots to be produced. (I5)

TITLE - Three card plot title. (8A10)

NCURVS - Number of curves per plot. (I5)

XØRG - Number of inches from the left paper margin to begin the X axis. (E10.3)

YØRG - Number of inches from the top of the paper margin to begin the Y axis. (E10.3)

DELX - Increment per inch on the X axis. (E10.3)

DELY - Increment per inch on the Y axis. (E10.3)

STARTX - First value on the X axis. (E10.3)

STARTY - First value on the Y axis. (E10.3)

LABELX - X axis label. (4A10)

LABELY - Y axis label. (4A10)

LEGEND - Legend for the curve. (4A10)

NDATA - File where the X and Y data are located. (I5)

NCØLX - Column on the data file where the X data is located. (I5)

NCØLY - Column on the data file where the Y data is located. (I5)

ISYM - Curve plotting symbol. (R1)

SCALEX - Scale factor to be applied to the X data. (E10.3)

SCALEY - Scale factor to be applied to the Y data. (E10.3)

NOTE:

1. Cards 3 through 9 may be eliminated by using option 12.
2. See Paragraph A.5.3.15 for a sample input.

### A.5.2.15 Option 18 - Produce a CalComp plot of the time history

1.

| 1-5 | 6-10 | 11-80 |
|---|---|---|
| NØPT | | LBLØUT |

2.

| 1-5 | 6-10 |
|---|---|
| NLIST | NPRNT |

3.

| 1-10 | 11-20 |
|---|---|
| K1 | NTAP |

Input the following cards if NLIST = 5.

4.

| 1-5 | 6-10 | 11-4 |
|---|---|---|
| NPLØTS | | I |

Input the following cards NPLØTS times.

5.

| 1 | 2-80 |
|---|---|
| | $PLØTD NCURVS=___, ANGLE=___, XPLØT=___, YPLØT=___, |

6.

| 1 | 2-80 |
|---|---|
|  | XEXIT=____, YEXIT=____, XLEGND=____, YLEGND=____, |

7.

| 1 | 2-80 |
|---|---|
|  | XØRG=__, YØRG=__, LNGTHX=__, LNGTHY=__, STARTX=__, |

8.

| 1 | 2-80 |
|---|---|
|  | STARTY=____, DELX=____, DELY=____, ISØPT=____ $END |

Input the following 4 cards if bit zero of ISØPT is one.

9.

| 1-80 |
|---|
| TITLE |

10.

| 1-80 |
|---|
| TITLE |

11.

| 1-80 |
|---|
| TITLE |

12.

| 1-80 |
|---|
| TITLE |

Input the following card if bit one of ISØPT is one.

13.

| 1-40 |  |
|---|---|
| LABELX |  |

Input the following card if bit two of ISØPT is one.

14.

| 1-40 |  |
|---|---|
| LABELY |  |

Input the following card if bit three of ISØPT is one.

15.

| | |
|---|---|
| 1-40 | |
| LEGEND | |

Input the following 5 cards if bit four of ISØPT is one.

16.

| | | |
|---|---|---|
| 1-10 | 11-20 | |
| X | Y | |

17.

| |
|---|
| 1-80 |
| TITLE |

18.

| |
|---|
| 1-80 |
| TITLE |

19.

| |
|---|
| 1-80 |
| TITLE |

20.

| |
|---|
| 1-80 |
| TITLE |

Input the following cards NCURVS times.

21.

| | |
|---|---|
| 1 | 2-80 |
| | $CURVE NDATA=___, NCØLX=___, NCØLY=___, NCX=___, |

22.

| | |
|---|---|
| 1 | 2-80 |
| | NCY=___, NCXY=___, LINTYP=___, DASH=___, NSYM=___, |

23.

| | |
|---|---|
| 1 | 2-80 |
| | SCALEX=___, SCALEY=___, SCALXX=___, SCALYY=___ $END |

```
24.        1-6    7-10              11-50
                              LABEL
```

where:

NØPT - Option number (input an 18 for this option). (I5)

LBLØUT - Option description. (7A10)

NLIST - File where the plot instructions are located. (I5)

NPRNT - Print flag to display input (NPRNT=0, no print) (I5)

K1 - CalComp plot code. (A10)

NTAP - File where CalComp writes its data. (A10)

NPLØTS - Number of plots to be produced. (I5)

I - Centimeter plot indicator. (A4)
I = "C.M." pen movements are in centimeter.

NCURVS - Number of curves per plot.

ANGLE - Plot rotation angle in degrees.

XPLØT - Distance in inches for which the origin of the plot is to be moved in the X direction.

YPLØT - Distance in inches for which the origin of the plot is to be moved in the Y direction.

XEXIT - Final pen movement in the X direction in inches.

YEXIT - Final pen movement in the Y direction in inches.

XLEGND - X coordinate of the plot legend in inches.

YLEGND - Y coordinate of the plot legend in inches.

XØRG - X value at which axes intercept (Default = 0.0).

YØRG - Y value at which axes intercept (Default = 0.0).

LNGTHX - Length of X axis in inches.

LNGTHY - Length of Y axis in inches.

STARTX - Initial value on the X axis.

STARTY - Initial value on the Y axis.

DELX - Increment per inch on the X axis.

DELY - Increment per inch on the Y axis.

ISØPT - Bit array for read option. See Figure A.4

BIT(0) = 1 - Read title to be centered over plot.<br>
BIT(1) = 1 - Read X axis label.<br>
BIT(2) = 1 - Read Y axis label.<br>
BIT(3) = 1 - Read legend title.<br>
BIT(4) = 1 - Read coordinates of the point and the title.

TITLE - Four card plot title. (8A10)

LABELX - X axis label. (4A10)

LABELY - Y axis label. (4A10)

LEGEND - Legend for the curve. (4A10)

X - X coordinate for plot title. (F10.0)

Y - Y coordinate for plot title. (F10.0)

NDATA - File where the plot data is located.

NCØLX - Column number on the data file where the X data is located.

NCØLY - Column number on the data file where the Y data is located.

NCX - Column number on the data file where the X elliptical axis data is located.

NCY - Column number on the data file where the Y elliptical axis data is located.

NCYY - Column number on the data file where the cross correlation data is located.

LINTYP - Type of line for the plot.

LINTYP = zero, line only (no symbol)

LINTYP = negative, symbol only (no line)

LINTYP = positive, both line and symbol

DASH - Length of plotting segments for dashed lines in inches. See Table A.1.

NSYM - CalComp symbol code (99 if ellipse).

SCALEX - Scale factor to be supplied to the X data (Default = 1.0).

SCALEY - Scale factor to be applied to the Y data (Default = 1.0).

SCALXX - Scale factor to be applied to the X elliptical axis (Default = 1.0).

SCALYY - Scale factor to be applied to the Y elliptical axis (Default = 1.0).

LSTYLE - Line style. See Table A.1. (Ø6)

LABEL - Legend for line style. (4A10)

NOTE:

1. Cards 3 through 24 may be input from file NLIST generated by option 13.
2. Ellipses of probability may be plotted by specifying NSYM = 99, NCX, NCY, and NCXY. See Figure A.3 for an example of a plot with ellipses of probability.
3. See Paragraph A.5.3.16 for a sample input.
4. See Figure A.2 for a diagram of the plot variables.

A.5.2.16 Option 19 - Print the time history in a blocked form

1.

| 1-5 | 6-10 | 11-80 |
|---|---|---|
| NØPT | | LBLØUT |

2.

| | |
|---|---|
| 1-5 | |
| NTAP | |

where:

NØPT - Option number (input a 19 for this option). (I5)

LBLØUT - Option description. (7A10)

NTAP - File to be printed. (I5)

NOTE:

1. See Paragraph A.5.3.17 for a sample input.

A.5.2.17 Option 21 - Generate a time history

1.

| | | |
|---|---|---|
| 1-5 | 6-10 | 11-80 |
| NØPT | | LBLØUT |

2.

| |
|---|
| 1-80 |
| TITLE |

3.

| |
|---|
| 1-80 |
| TITLE |

4.

| |
|---|
| 1-80 |
| TITLE |

5.

| |
|---|
| 1-80 |
| TITLE |

6.

| | | | | | |
|---|---|---|---|---|---|
| 1-5 | 6-10 | 11-15 | 16-20 | 21-25 | |
| NLIST | NTAP | NDATA | INT | NPRNT | |

Input the following three cards as many times as needed if NLIST = 5.

7.

| 1-5 | 6-10 | 11-15 | 16-20 | 21-70 | 71-80 |
|---|---|---|---|---|---|
| I | J | K | L | LABEL | SCALE |

Input the following card if I < 0.

8.

| 1-40 | 41-80 |
|---|---|
| FMTI | FMTØ |

9.

| 1-10 | 11-20 | 21-30 | | 71-80 |
|---|---|---|---|---|
| R(I+J) | R(I+J+1) | R(I+J+2) | . . . | R(K+L) |

Input the following two cards as many times as needed if NTAP = 5.

10.

| 1-5 | 6-10 | 11-15 | 16-20 | 21-70 | 71-80 |
|---|---|---|---|---|---|
| I | J | K | L | LABEL | SCALE |

Input the following card if I < 0.

11.

| 1-40 | |
|---|---|
| FMTØ | |

where:

NØPT - Option number (input a 21 for this option) (I5)

LBLØUT - Option description. (7A10)

TITLE - Four card title for problem definition. (8A10)

NLIST - File containing the R array input instructions for the integration variables. (I5)

NTAP - File containing the R array output instructions for the initial integration print. (I5)

NDATA - File to be written containing the time history output. Variables set up by option 7. (I5)

INT - Integration option. (I5)

INT = 1 - Fourth order Runge-Kutta.<br>
INT = 2 - Third order Runge-Kutta.<br>
INT = 3 - Second order Adams.

NPRNT - Print the time history as a block of data. (I5)

I - Beginning segment number of the R array. (I5)

J - Beginning element number of the R array. (I5)

K - Ending segment number of the R array. (I5)

L - Ending element number of the R array. (I5)

LABEL - Variable names for the elements between I,J and K,L. (4A10)

SCALE - Scale factor to be applied to R array data between I,J and K,L. (E10.3)

FMTI - Variable input format for inputting data into the R array for card 9 above. (4A10)

FMTØ - Variable output format for printing data from the R array. (Default = 7F14.5). (4A10)

R -
R array elements. (F10.3)

NOTE:

1. Cards 7, 8, and 9 are input through Option 4. The branch to Option 4 occurs within Option 21 and is invisible to the user. Any R array element may be input through this option. To terminate the read for cards 7, 8, and 9, a blank card for I,J,K,L must be input.

2. If NLIST ≠ 5, cards 7 and 8 are input through file NLIST. Card 9 is input through file 5 (INPUT).

3. Cards 10 and 11 are input through option 5. These cards print the results of trim and the call to Setup. Any R array elements may be printed at this time. To terminate the read for cards 10 and 11, input a blank card for I,J,K,L.

4. If NTAP ≠ 5, input cards 10 and 11 through file NTAP.

5. See Paragraph A.5.3.18 for a sample input.

A.5.2.18 Option 28 - Store or retrieve R array data to or from a file (TAPE28)

1.

| 1-5 | 6-10 | 11-80 |
|---|---|---|
| NØPT | | LBLØUT |

2.

| 1-5 | |
|---|---|
| K1 | |

3.

| 1-5 | 6-10 | 11-15 | 16-20 | 21-70 | 71-80 |
|---|---|---|---|---|---|
| I | J | K | L | LABEL | SCALE |

where:

NØPT - Option number (input a 28 for this option). (I5)

LBLØUT - Option description. (7A10)

K1 - Data option flag. (I5)

K1 = 0 - Read data from a file (TAPE28).

K1 ≠ 0 - Write data to a file (TAPE28).

I - Beginning segment number of the R array to be read/written from/to the file. (I5)

J - Beginning element number of the R array to be read/written from/to the file. (I5)

K - Ending segment number of the R array to be read/written from/to the file. (I5)

L - Ending element number of the R array to be read/written from/to the file. (I5)

LABEL - Variable names appearing between segments I,J to K,L. (5A10)

SCALE - Scale factor to be applied to the R array. (E10.3)

NOTE:

1. Multiple sets of card 3 may be input.
2. To terminate option 28, a blank card for I,J,K,L must be input.
3. See Paragraph A.5.3.19 for a sample input.

## A.5.3 Sample Input for Each Program Option

The following examples are sample inputs for the initialization phase and the program options.

### A.5.3.1 Sample of program initialization

```
$SEGMNT NSEGI=7, NSEGR=143, NPRNT=1,
        NI(1)=10,0,0,14,14,6,
        NR(1)=6,17,17,26,18,11,37,66,9,37,
        NR(11)=14,18,6,10,0,6,19,0,0,10,
        NR(21)=10,10,10,10,10,0,6,6,6,6,
        NR(31)=6,6,6,6,6,6,6,6,6,6,
        NR(41)=6,6,6,6,6,6,6,6,0,289,
        NR(51)=289,289,44,16,50,50,75,75,75,75,
        NR(61)=75,75,6,6,6,6,6,6,6,6,
        NR(71)=6,6,6,6,6,6,6,6,6,6,
        NR(81)=36,24,42,49,28,1,1,1,1,24,
        NR(91)=16,1,1,1,1,1,1,1,1,1,
        NR(101)=1,1,1,1,1,1,12,6,6,6,
        NR(111)=6,6,6,6,6,6,6,6,6,6,
        NR(121)=6,6,6,6,6,6,6,6,6,6,
        NR(131)=6,6,6,6,10,10,10,10,10,4,
        NR(141)=4,4,4,
$END
```

### A.5.3.2 Sample of Option 1

```
  1        STORE R ARRAY INSTRUCTIONS ON A FILE.
  3
  6    1     6    6  WEIGHT,G,IX,IY,IZ,IXZ
  6    7     6    9  LM, WM, LTDM
  7    9     7    9  TAUD
  7   28     7   29  OMEGAV, KV
  7   30     7   35  TAUA, K1, K2, KY, B1, B2
 13    1    13    6  TABV1  (V TABLE FOR AERO DATA)                            1.688
 14    1    14   10  TABV2  (TIME TABLE FOR OPEN LOOP INPUTS)
 20    1    20   10  TABTC  (OPEN LOOP THETA)
120    1   120    6  TYV
121    1   121    6  TYP
122    1   122    6  TYR
123    1   123    6  TYDA
124    1   124    6  TYDR
125    1   125    6  TLV
126    1   126    6  TLP
127    1   127    6  TLR
128    1   128    6  TLDA
129    1   129    6  TLDR
130    1   130    6  TNV
131    1   131    6  TNP
132    1   132    6  TNR
133    1   133    6  TNDA
134    1   134    6  TNDR
135    1   135   10  TABUB
136    1   136   10  TABWB
137    1   137   10  TXAPP
138    1   138   10  TZAPP
139    1   139   10  TXSP
140    1   140    4  TDAIN
141    1   141    4  TDAOUT
142    1   142    4  TDRIN
143    1   143    4  TDROUT
                     BLANK CARD FOR READ R
```

### A.5.3.3 Sample of Option 2

```
  2        READ INTO I ARRAY
  5    5    0
  1    3    1    6  NSTATES, NPA, NOM, NGM
 11   17    4   11
  1    7    1   10  NPE, NPX, NOAW, NOINIT
  1    1    0    1
                     BLANK CARD FOR READ I
```

### A.5.3.4 Sample of Option 3

```
  3         PRINT DATA FROM THE I ARRAY
  5
  1    3    1    6  NSTATES, NPA, NOM, NGM
  1    7    1   10  NPE, NPX, NOAW, NOINIT
                    BLANK CARD TO TERMINATE OPTION 3
```

### A.5.3.5 Sample of Option 4

```
   4        READ R   (CASE-PARTICULAR INPUT)
   5    5    0
   8   14    8   14  VAMB                                    1.688
20.
   8   15    8   15  PSIAMB                                  .01745329
150.
   8   10    8   10  V5  (SHIP SPEED)                        1.688
20.
   8   11    8   11  PSI5 ((SHIP HEADING)                    .01745329
30.
   8    3    8    5  UAS, VAS, WAS
74.71     -7.012    10.495
   3   15    3   16  PHI, PSI                                .01745329
-1.        0.
   5   10    5   12  SUMFYO, SUMLO, SUMNO
290.41     0.        0.
   2   17    2   17  YSP
0.
   2   14    2   14  YAPP
0.
   7   36    7   37  TL1, TL2
10.        2.
  16    5   16    6  GAINDA, GAINDR
1.         1.
                     BLANK CARD TO TERMINATE OPTION 4
```

### A.5.3.6 Sample of Option 5

```
   5        PRINT DATA FROM THE R ARRAY
   5
   2    1    2    5  UDOT, WDOT, QDOT, TDOT, XAPPDOT
  -8    1    8    6  ALT, VAIR, UBAS, VBAS, WBAS, ALPHA
(6E20.10)
                     BLANK CARD TO TERMINATE OPTION 5
```

### A.5.3.7 Sample of Option 6

```
  6          SETUP DIFFERENTIAL EOUATIONS
  4    1
  2   11     2   17   VDOT,PDOT,RDOT,YAPPDOT,PHIDOT,PSIDOT,YSPDOT
 12   15    12   18   DA1D,DA2D,DP1D,DR2D
                      BLANK CARD TO TERMINATE DERIVATIVES
  5    1
  3   11     3   17   VB, PB, RB, YAPP, PHI, PSI, YSP
 12   11    12   14   DA1,DA2,DR1,DR2
                      BLANK CARD TO TERMINATE STATES
  6    1
 52    1    51    1   PDOT, P
                      BLANK CARD
  6    3
100    1    99    1   PED, PE
                      BLANK CARD
  6    5
104    1   103    1   PXHATD, PXHAT
                      BLANK CARD, END OF OPTION 6
```

### A.5.3.8 Sample of Option 7

```
  7          DESIGNATE OUTPUT VARIABLES
  1    1     1    1   TIME
  8    1     8    2   ALT, VAIR
  3    5     3    6   XAPP, ZAPP
  3   14     3   14   YAPP
  3   17     3   17   YSP
  3   15     3   16   PHI, PSI
 12    7    12    8   DA, DR
 16    3    16    4   SIGDA, SIGDR
  3   11     3   11   VB
  3    1     3    2   UB, WB
  8   27     8   29   XM, YM, ZM
  8   30     8   32   PSIA, THETAA, PHIA
  8   33     8   35   SIGMAVX, SIGMAVY, SIGMAVZ
  8   39     8   42   UWIND, UMEAN, UR, UAW
  8   43     8   46   VWIND, VMEAN, VR, VAW
  8   47     8   5C   WWIND, WMEAN, WR, WAW
 55    1    55   17   SIGMAS OF THE STATES
 11    9    11    9   ERY
 16    1    16    2   SIGDAP, SIGDRP
                      BLANK CARD TO TERMINATE OPTION 7
```

### A.5.3.9 Sample of Option 10

```
   10        CREATE A FILE COMPATIBLE FOR OPTION 18
    5
    5    8    0
1.0       2.0       3.0       4.0       5.0       6.0       7.0       8.0
1.1       2.1       3.1       4.1       5.1       6.1       7.1       8.1
1.2       2.2       3.2       4.2       5.2       6.2       7.2       8.2
1.3       2.3       3.3       4.3       5.3       6.3       7.3       8.3
1.4       2.4       3.4       4.4       5.4       6.4       7.4       8.4
1.5       2.5       3.5       4.5       5.5       6.5       7.5       8.5
```

### A.5.3.10 Sample of Option 11

```
11          STORE TABBING INSTRUCTIONS
 2     0
 9
10     1    TIME
10     2    ALT
10     3    VA-KTS                                                   .5924
10     8    PHI                                                      57.3
10     9    PSI                                                      57.3
10     4    XAPP
10     6    YAPP
10     7    YSP
10    55    ERY
10
10     1    TIME
10    14    VB
10    30    VWIND
10    31    VMEAN
10    33    VAW
10    24  SIGMAVY
10    10    DA
10    11    DR
10    12   SIGDA
10    13   SIGDR
10
10     1    TIME
10    38   SIGV
10    39  SIGP-DEG                                                   57.3
10    40  SIGR-DEG                                                   57.3
10    41   SIGPHI                                                    57.3
10    42   SIGPSI                                                    57.3
10    43   SIGY
10    20   PSIA                                                      57.3
10    21   THETAA                                                    57.3
10    22   PHIA                                                      57.3
 5
10     1    TIME
10    56   SIGDAP
10    57    SIGDRP
10    12    SIGDA
10    13    SIGDR
                   BLANK CARD TO TERMINATE OPTION 11
```

A.5.3.11 Sample of Option 12

```
   12       STORE PRINTER PLOTTER INSTRUCTIONS ON A FILE.
   3
   3
                           VOLAR CHECKOUT - 16 FEB 78
                        EFFECT OF AIRWAKE ON SIMPLE MODEL
                                   UAW VS TIME
    1     0.0        7.0       3.0       1.0
               TIME - SEC.                              UAW     FT/SEC.
UAW IN FEET PER SECOND.                     10    1   40 U 1.0       1.0
                           VOLAR CHECKOUT - 16 FEB 78
                        EFFECT OF AIRWAKE ON SIMPLE MODEL
                                   WAW VS TIME
    1     0.0        0.0       3.0       1.0
               TIME - SEC.                              WAW     FT/SEC.
WAW IN FEET PER SECOND.                     10    1   48 W 1.0       1.0
                           VOLAR CHECKOUT - 16 FEB 78
                        EFFECT OF AIRWAKE ON SIMPLE MODEL
                                   VAW VS TIME
    1     0.0        7.0       3.0       1.0
               TIME - SEC.                              VAW     FT/SEC.
VAW IN FEET PER SECOND.                     10    1   44 V 1.0       1.0
```

A.5.3.12 Sample of Option 13

```
   13          STORE CALCOMP PLOTTER INSTRUCTIONS ON A FILE.
    2
CAL34      PLOT
    9
 $PLOTD NCURVS=1,XPLOT=2.0,YPLOT=0.5,ANGLE=0.0,LNGTHX=5.0,STARTX=500.0,
        DELX=-100.0,XORG=500.0,LNGTHY=4.0,STARTY=0.0,DELY=2.0,YORG=0.0,
        ISOPT=22,$END
          RANGE FROM SHIP - FT.
          SIGMA APP. PATH - FT.
5.0       9.75
    VOLAR CHECKOUT
      14 FEB 78
  EFFECT OF AIRWAKE
   ON SIMPLE MODEL
 $CURVE NDATA=10,NCOLX=21,NCOLY=31,LINTYP=0,DASH=0.01,SCALEX=1.0,
        SCALEY=1.0,$END
177777
 $PLOTD NCURVS=2,XPLOT=0.0,YPLOT=5.5,XLEGND=0.25,YLEGND=1.00,
        DELY=50.0,ISOPT=12,$END
              ALTITUDE - FT.
50 PERCENT PROB. ELLIPSE X 5
 $CURVE NCOLY=2,NSYM=99,LINTYP=10,NCX=23,NCY=24,NCXY=53,
        SCALXX=5.0,SCALYY=5.0,$END
177777    ACTUAL
 $CURVE NCOLY=16,LINTYP=0,SCALEY=-1.0,$END
170360    COMMANDED
 $PLOTD NCURVS=1,XPLOT=7.5,YPLOT=0.0,DELY=2.0,ISOPT=4,$END
            SIGMA XAP - FT.
 $CURVE NCOLY=23,SCALEY=1.0,$END
177777
 $PLOTD NCURVS=1,XPLOT=0.0,YPLOT=-5.5,DELY=2.0,$END
            SIGMA ZAP - FT.
 $CURVE NCOLY=24,$END
177777
 $PLOTD    XPLOT=9.5,YPLOT=0.,DELY=2.     $END
              SIGMA THETA - DEG.
 $CURVE    NCOLY=22, SCALEY=57.3    $END
177777
 $PLOTD XPLOT=0.0,YPLOT=5.5,STARTY=-8.0,DELY=4.0,$END
                THETA - DEG.
 $CURVE    NCOLY=4    $END
177777
 $PLOTD   . XPLOT=7.5,YPLOT=0.,STARTY=-.2,DELY=.1    $END
              DE - UNITS
 $CURVE    NCOLY=7, SCALEY=1.  $END
177777
 $PLOTD    XPLOT=0.,YPLOT=-5.5,STARTY=0.,DELY=.05  $END
           SIGMA DE - UNITS
 $CURVE    NCOLY=28  $END
177777
 $PLOTD    XPLOT=9.5,YPLOT=0.,DELY=10.0  $END
            SIGMA RPM - RPM
 $CURVE    NCOLY=25  $END
177777
```

A.5.3.13 Sample of Option 14

```
      14     TAB THE OUTPUT
       2     TAB INSTRUCTIONS STORED ON FILE 2
```

A.5.3.14 Sample of Option 15

```
         15        PUNCH TIME HISTORY
          3
```

A.5.3.15 Sample of Option 17

```
   17      PRODUCE PRINTER PLOTS
    5    1
    3
                          VOLAR CHECKOUT - 16 FEB 78
                       EFFECT OF AIRWAKE ON SIMPLE MODEL
                                  UAW VS TIME
    1     0.0       7.0       3.0       1.0
              TIME - SEC.                                     UAW       FT/SEC.
UAW IN FEET PER SECOND.                    10    1 4C U 1.0       1.0
                          VOLAR CHECKOUT - 16 FEB 78
                       EFFECT OF AIRWAKE ON SIMPLE MODEL
                                  WAW VS TIME
    1     0.0       0.0       3.0       1.0
              TIME - SEC.                                     WAW       FT/SEC.
WAW IN FEET PER SECOND.                    10    1 48 W 1.0       1.0
                          VOLAR CHECKOUT - 16 FEB 78
                       EFFECT OF AIRWAKE ON SIMPLE MODEL
                                  VAW VS TIME
    1     0.0       7.0       3.0       1.0
              TIME - SEC.                                     VAW       FT/SEC.
VAW IN FEET PER SECOND.                    10    1 44 V 1.0       1.0
```

### A.5.3.16 Sample of Option 18

```
   18       PRODUCE CALCOMP PLOTS
    5    1
 CAL34      PLOT
   10
 $PLOTD NCURVS=2,XPLOT=.75,YPLOT=0.0,ANGLE=0.0,LNGTHX=4.0,STARTX=0.0,
        DELX=5.0,XORG=0.0,LNGTHY=4.0,STARTY=00.0,DELY=40.0,YORG=0.0,
        ISOPT=6 ,XLEGND=2.0,YLEGND=1.0 $END
              TIME - SEC.
            LATERAL POS. - M.
 $CURVE DASH=.01,NDATA=10,NCOLX=1,NCOLY=6,LINTYP=0,SCALEX=1.0,SCALEY=.3048 $END
177777
 $CURVE DASH=.01,NDATA=10,NCOLY=7,$END
170360     COMMANDED
 $PLOTD NCURVS=1,XPLOT=0.0,YPLOT=5.0,LNGTHY=4.0,STARTY=0.0,DELY= 1.0,YORG=0.0,
        ISOPT=4,XLEGND=2.0,YLEGND=4.5,$END
           SIGMA LAT. POS. - M.
 $CURVE DASH=.01,NDATA=10,NCOLY=43,SCALEX=1.0,SCALEY=.3048 $END
177777
 $PLOTD NCURVS=1,XPLOT=5.5,YPLOT=-5.0,LNGTHY=4.0,STARTY=-4.0,DELY=2.0,YORG=0.0,
        ISOPT=4,XLEGND=2.0,YLEGND=3.5 $END
            BANK ANGLE - -DEG.
 $CURVE DASH=.01,NDATA=10,NCOLY=8,SCALEX=1.0,SCALEY=57.3 $END
177777
 $PLOTD NCURVS=1,XPLOT=0.0,YPLOT=5.0,LNGTHY=4.0,STARTY=0.0,DELY= 2.0,YORG=0.0,
        ISOPT=4,XLEGND=2.0,YLEGND=4.5,$END
            SIGMA PHI - DEG.
 $CURVE DASH=.01,NDATA=10,NCOLY=41,SCALEX=1.0,SCALEY=57.3 $END
177777
 $PLOTD NCURVS=1,XPLOT=5.5,YPLOT=-5.0,LNGTHY=4.0,STARTY=-0.2,DELY=0.1,YORG=0.0,
        ISOPT=4,$END
           ROLL CONTROL - UNITS
 $CURVE DASH=.01,NDATA=10,NCOLY=10,SCALEX=1.0,SCALEY=1.0,$END
177777
 $PLOTD NCURVS=1,XPLOT=0.0,YPLOT=5.0,LNGTHY=4.0,STARTY=0.0,DELY=.20,YORG=0.0,
        ISOPT=4,XLEGND=2.0,YLEGND=4.5,$END
      SIGMA ROLL CONTROL - UNITS
 $CURVE DASH=.01,NDATA=10,NCOLY=56,SCALEX=1.0,SCALEY=1.0,$END
177777
 $PLOTD NCURVS=1,XPLOT=6.0,YPLOT=-5.0,LNGTHY=4.0,STARTY= -.02,DELY=.01,
        YORG=0.0,ISOPT=4,$END
           YAW CONTROL - UNITS
 $CURVE DASH=.01,NDATA=10,NCOLY=11,SCALEX=1.0,SCALEY=1.0,$END
177777
 $PLOTD NCURVS=1,XPLOT=0.0,YPLOT=5.0,LNGTHY=4.0,STARTY=0.0,DELY=  .01,YORG=0.0,
        ISOPT=4,XLEGND=2.0,YLEGND=4.5,$END
      SIGMA YAW CONTROL - UNITS
 $CURVE DASH=.01,NDATA=10,NCOLY=57,SCALEX=1.0,SCALEY=1.0,$END
177777
 $PLOTD NCURVS=1,XPLOT=5.5,YPLOT=-5.0,LNGTHY=4.0,STARTY= -2.0,DELY=1.0,
        YORG=0.0,ISOPT=4,$END
           LAT. POS. ERROR - M.
 $CURVE DASH=.01,NDATA=10,NCOLY=55,SCALEX=1.0,SCALEY=.3048,$END
177777
 $PLOTD NCURVS=1,XPLOT=0.0,YPLOT=5.0,LNGTHY=4.0,STARTY=0.0,DELY=1.0,YORG=0.0,
        ISOPT=4,XLEGND=2.0,YLEGND=4.5,$END
             VAW - M/SEC.
 $CURVE DASH=.01,NDATA=10,NCOLY=33,SCALEX=1.0,SCALEY=.3048,$END
177777
```

A.5.3.17 Sample of Option 19

```
 19          PRINT A FILE IN BLOCKED FORM.
 18
```

A.5.3.18 Sample of Option 21

```
      21     GENERATE A TIME HISTORY BY COVARIANCE PROPAGATION.
        ******************************
        **          AV-8A           **
        **     35 KT WOD, LAT/DIR   **
        ******************************
         5    5   10    3    0
         1    3    1    6 DTIME, DTOUT, DTOUT2, TMAX
  0.0125    0.2        5.0       5.0
                         BLANK CARD FOR READ R
         8    1    8   66  PRINT SEGMENT 8
                         BLANK CARD FOR WRITE R
```

A.5.3.19 Sample of Option 28

```
        28         STORE R ARRAY VALUES ON TAPE28
         1         FILE TO BE CREATED
        51    1    51 2764  P ARRAY
        99    1    99  324  PE ARRAY
       103    1   103  324  PXHAT ARRAY
        93    1    93    9  VU ARRAY
        94    1    94   36  VY ARRAY
                            BLANK CARD TO TERMINATE OPTION 28
```

### A.5.4 Program Output

The program's output is divided into four categories: disk storage, printed output, plotted output and punched output. Before the time history output can be printed, plotted, or punched, it has to be stored on a file.

#### A.5.4.1 Disk storage

Disk storage is divided into two sections: instructions and time history.

##### A.5.4.1.1 Instruction storage

Option 1 stores I or R array instructions on a file. Options 2 and 4 have the capability of storing I and R array instructions with the data on a file by specifying the NPF parameter. Options 11, 12, and 13 store tabulating and plotting instructions on a file. Option 28 stores only the R array values on a file.

##### A.5.4.1.2 Time history storage

Option 21 stores the time history output (specified by Option 7) on a file. Option 10 reads input and creates a file of the same structure as the time history file. This file is thus compatible with the program's output features.

#### A.5.4.2 Printer output

The time history output can be printed in two forms: tabular and blocked.

##### A.5.4.2.1 Tabular output

Once the time history has been generated and stored on a file (A.5.4.1.2), a tabular print of the output can be produced by using Options 11 and 14. Option 11 designates which elements from the stored file (A.5.4.1.2) are to be printed along with page title and column headings. Option 14 produces the tabular print. See paragraphs A.5.3.10 and A.5.3.13 for examples of Options 11 and 14 respectively.

##### A.5.4.2.2 Blocked output

The contents of a file can be printed in a blocked form by using Option 19. The output elements are not titled but appear in the same order as they appear on the file being dumped. Option 21 has the capability to print the time history in a blocked form by specifying NPRNT ≠ 0. This is to be used for debugging because the print is generated every DTØUT seconds until job termination. When using Option 14 to tab the output, the job must have executed normally. See paragraphs A.5.3.17 and A.5.3.19 for examples of Options 19 and 21 respectively.

### A.5.4.3 Plot output

The time history output can be plotted in two forms: CalComp plots and printer plots.

#### A.5.4.3.1 CalComp plots

After the time history has been placed on a file (A.5.4.1.2), a CalComp plot can be produced by using Option 18. See the text for examples of the plots. See paragraph A.5.3.16 for an example of Option 18.

#### A.5.4.3.2 Printer plots

After the time history has been placed on a file (A.5.4.1.2), a printer plot can be produced by Option 17. The plots consist of a 7 by 7 inch grid with one plot per page. See paragraph A.5.3.15 for an example of Option 17. See Figure A.5.4.3.2 for a sample printer plot.

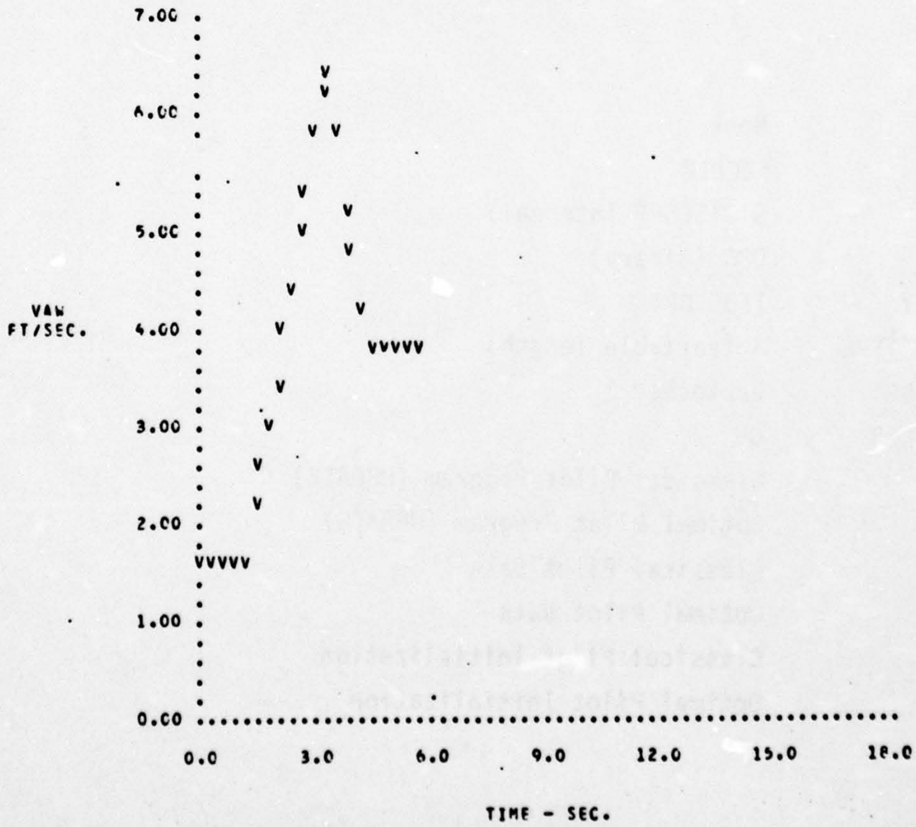


Figure A.5.4.3.2

### A.5.4.4 Punched output

After the time history has been placed on a file (A.5.4.1.2), punched cards can be produced by using Options 11 and 15. Option 11 designates which elements from the stored file are to be punched. Option 15 produces the punched cards. See paragraphs A.5.4.10 and A.5.4.14 for examples of Options 11 and 15 respectively.

## A.6 Program Flow

An overall picture of program flow is illustrated in Figure A.5.

## A.7 Discussion of Control Cards

The following discussion of control cards is sufficient to place the VOLAR program online and execute its sample problems.

### A.7.1 Transferring the Data from Magnetic Tape to Disk

Table A.2 is a description of how the tape was created.

Table A.2

| | |
|---|---|
| TRACK | 9 |
| LABEL | None |
| CODE | EBCDIC |
| FORMAT | SI (SCOPE Internal) |
| PARITY | ODD (Binary) |
| DENSITY | 1600 BPI |
| RECORD TYPE | S (Variable length) |
| BLOCKING | Unblocked |
| NO. FILES | 6 |
| 1 | Classical Pilot Program (UPDATE) |
| 2 | Optimal Pilot Program (UPDATE) |
| 3 | Classical Pilot Data |
| 4 | Optimal Pilot Data |
| 5 | Classical Pilot Initialization |
| 6 | Optimal Pilot Initialization |

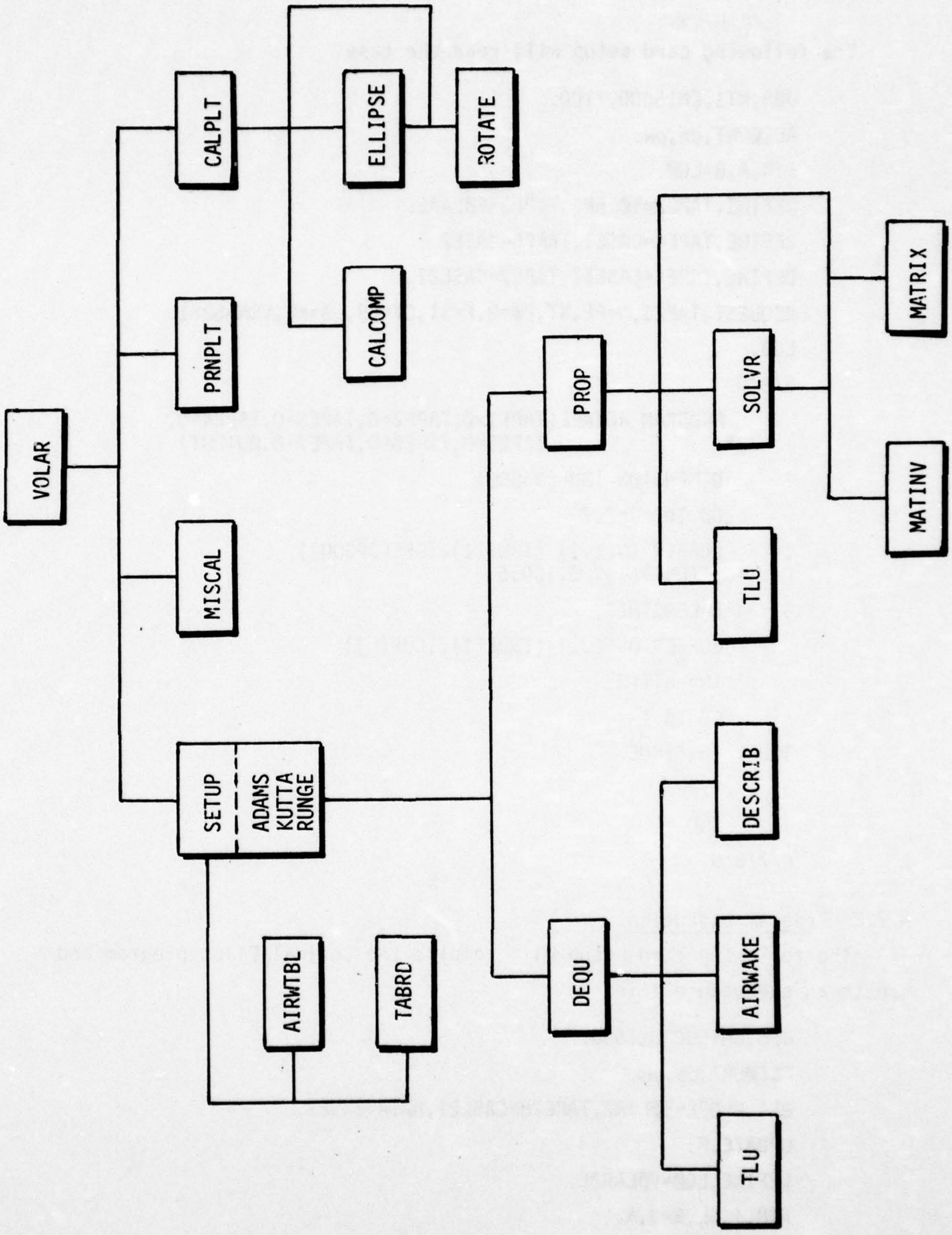

VOLAR
CALPLT
PRNPLT
MISCAL
SETUP
ADAMS KUTTA RUNGE
ELLIPSE
ROTATE
CALCOMP
AIRWTBL
TABRD
PROP
DEQU
SOLVR
TLU
MATRIX
MATINV
DESCRIB
AIRWAKE
TLU

Figure A.5

The following card setup will read the tape:

```
JØB,NT1,CM15000,T100.
ACCØUNT,cn,pw.
FTN,A,B=LGØ.
DEFINE,TAPE2=VØLAR1,TAPE3=VØLAR2.
DEFINE,TAPE4=CASE1,TAPE5=CASE2.
DEFINE,TAPE6=CASE1I,TAPE7=CASE2I.
REQUEST,TAPE1,D=PE,NT,PØ=R,F=SI,CV=EB,LB=KL,VSN=5251.
LGØ.
7/8/9
      PRØGRAM RDTAPE(TAPE1=0,TAPE2=0,TAPE3=0,TAPE4=0,
     *               TAPE5=0,TAPE6=0,TAPE7=0,ØUTPUT)
      DIMENSIØN IBUF(30000)
      DØ 100 J=2,7
1     BUFFER IN(1,1) (IBUF(1),IBUF(30000))
      IF(UNIT(1)) 5,100,5
5     L=LENGTH(1)
      BUFFER ØUT(J,1)(IBUF(1),IBUF(L))
      IN=UNIT(J)
      GØ TØ 1
100   CØNTINUE
      STØP
      END
6/7/8/9
```

A.7.2 Program Execution

The following card setup will compile the Optimal Pilot program and create an executable file:

```
JØB,CM150000,T500.
ACCØUNT,cn,pw.
GET,ØLDPL=VØLAR2,TAPE28=CASE2I,DATA=CASE2.
UPDATE,F.
DEFINE,LGØ=VØLAR2E.
FTN,I,SL,R=3,A.
```

```
MAP,FULL.
LDSET,PRESET=ZERØ,LIB=CALCØMP.
LGØ,DATA.
7/8/9
6/7/8/9
```

### A.7.3 Program Modification

The following card setup will modify one of the routines in the Optimal Pilot program and execute the program.

```
JØB,CM150000,T500.
ACCØUNT,cn,pw
GET,ØLDPL=VØLAR2,ØLD=VØLAR2E.
UPDATE.
FTN,I,SL,R=3,A.
CØPYL.
MAP,FULL.
LDSET,PRESET=ZERØ,LIB=CALCØMP.
NEW.
7/8/9
     UPDATE CHANGE CARDS GØ HERE.
7/8/9
     INPUT DATA CARDS GØ HERE.
6/7/8/9
```

## A.8 Discussion of Input Deck for the Classical Pilot Model Simulation

The purpose of this section is to lead the prospective user of VOLAR through a sample input deck. The discussion here will focus on the necessary flow of options to generate a time history and point out any special input requirements that might not be obvious to the new user. This input deck is identical to the one which generated the AV-8A classical pilot model simulation and plots for the case with control limiting. After studying this section the user should run this case on his computer.

A schematic of the job setup to run this case is presented in Figure A.6. Figure A.7 is a listing of the input deck. The circled numbers provide a cross reference to this test; i.e., the cards following ④ are discussed below in Section A.8.4.

Throughout the discussion of this input deck,it may be beneficial to the reader to refer to the description in Section A.5 of the main program and its options.

### A.8.1 Namelist Input

The first step is to provide the main program with the information required to bookkeep the I and R arrays. The namelist SEGMNT establishes the number of segments in each array and the number of elements in each segment. The format for NAMELIST inputs can be found in the CDC FORTRAN manual.

The namelist SEGMNT is the one and only mandatory input. All other inputs are either user selected options or input required by the chosen option.

For this case the I array is seven segments long, and the R array is composed of 143 segments. The NPRNT = 1 causes the I and R array segmentation information to be output. The lengths of the segments are consistent with the I and R arrays presented in Appendix E.

### A.8.2 Option 2

Integer values that define system size and control the selection of certain calculations are input here. These parameters are defined in Appendix E.

Although NPE and NPX are dimensions of matrices used only in the optimal pilot case,they are given a value of one (1) here. The reason is the integration subroutines expect to integrate a set of means and three matrices. By giving NPE and NPX a small value, a negligible increase in run time is traded for the simplicity of having only one set of integration subroutines. This keeps the number of problem dependent subroutines to an absolute minimum.

This run will include the ship airwake (NOAW = 0) and is not an initialization run (NOINIT = 1).

### A.8.3 Option 4

Required values of the R array are input next. At Vought fixed geometric and aerodynamic properties are input here. Case-dependent information is input later in the deck. At the beginning of job execution, the 'LDSET, PRESET = ZERO' control card initializes core to zero. Therefore, parameters not initialized through Option 4 begin with a value of zero.

Note that the inertias are input here as 1 (obviously not the true value). However, they are not required to generate accelerations (Vought used dimensional derivatives) but inertias do appear in SETUP in a denominator. This is all related to the calculation of forces and moments in DEQU, where the total forces and moments that drive the mean equations must be obtained from a reference condition and the perturbation forces and moments.

Tables defining the independent variable arrays, open loop inputs, aerodynamic data and nonlinear elements are also input here.

The weight and aerodynamic derivatives are from Reference 15. The ship geometry inputs represent a DD-963. Feedback gains and time constants are for the classical pilot model discussed in Section 6. The values of TABUB, TABWB, TXAPP, TZAPP, and TXSP were derived from the task description. These tables provide the reference longitudinal values required by the lateral/directional equations. The final four tables define the nonlinear functions (control limiters) discussed in Section 4.

### A.8.4 Option 6

Here the user specifies the variables that are to be integrated and the variables that contain the integrated values. This option allows one to use any variable in blank COMMON as an integrand or integrated value.

Note that the setup includes the matrices PED, PE, PXHATD, and PXHAT. These are associated with the optimal pilot model and not required by the classical model. In Section A.8.2 it was noted that these are specified as 1 by 1 matrices (NPE and NPX) and included in this setup to avoid the need for two sets of integration subroutines.

A.8.5 Option 7

The variables specified here appear on the output file. Their selection is totally up to the user. All of the output features (tabbing, plotting, etc.) access the file containing the Option 7 specified variables.

A.8.6 Option 11

The variables to be tabbed are user defined. Here it was attempted to tabulate all the key parameters for interpreting the performance of a given task.

A.8.7 Option 4

The case-particular input goes here. The order is not important.

The first two terms in this input are ambient wind magnitude and direction. The ambient wind gets into the calculation of airspeed and wind over deck.

The ship's speed and heading are also input. The ambient wind and ship conditions were selected to give 35 knots wind over deck comming at 30 degrees to port. This value is a 'breakpoint' in the ship airwake model data tables.

The initial body axis components of airspeed are necessary to initialize the airplane inertial speed. Aside from this exception, airspeeds are calculated in DEQU from inertial speeds. This particular representation was chosen because it was felt that most often the airplane flight conditions would be specified by stating an airspeed, angle-of-attack, and sideslip. If this is undesirable, the user can modify DEQU to meet his needs. The mean components of the airwake, that enter into the calculation of airspeed, may be obtained by requesting a zero second time history after specifying the airplane and ship positions in space.

The initial aircraft bank angle is -1 degree, and the aircraft's heading is zero degrees. The bank angle is required to balance out the initial side force on the airplane. The initial side force is due to the non-zero value of sideslip (VAS ≠ 0).

The value of SUMFYO was obtained from $Y_v$. The initial values of SUMLO and SUMNO are zero. It is assumed that the roll and yaw controls would trim out the moments due to $N_v'$ and $L_v'$ so that the total moments on the airplane are zero. SUMFYO, SUMLO, and SUMNO are total force and moments on the airplane and are required in subroutine SETUP to initialize YO, LO, and NO.

The initial displacements of the ship and airplane along the y earth axis are input as zero. The x-axis displacements of the ship and airplane, and the z axis displacement of the airplane were previously input in table form.

### A.8.8 Option 28

This option reads data stored from a previous run. It is used here to initialize the P matrix.

In the previous run, NOINIT was set to -1 (all other input discussed to this point remains unchanged). This froze the means and integrated only the covariance matrix. When NOINIT = -1, Option 28 should follow Option 21. Refer to Section A.5 for using Option 28 in a BUFFER IN or BUFFER OUT mode.

This initialization is necessary to start the P matrix at realistic values. Because the airplane did not suddenly appear at a point 16 seconds away from the ship, beginning with P = 0 is unrealistic. The airplane flew through the atmosphere (and its disturbances) to get to the point in the trajectory where the VOLAR simulation picks it up. The question then becomes one of determining what is a realistic method to use for initializing the covariance matrix.

Subroutine SOLVR provides a method for initializing P. SOLVR calculates the steady-state (i.e. $t \to \infty$) value of P. This solution would provide an upperbound on the uncertainties (i.e. the value of P). However, SOLVR will not work for the optimal pilot cases because there are three inter-related covariance matrices, and it is programmed to solve only one. Also, one might argue that $t \to \infty$ statistics may not be realistic either. Note that if the system is unstable, $P \to \infty$ as $t \to \infty$.

The approach selected here was to integrate the P matrix for some period of time. Five seconds was selected. For a stable system, the P matrix will approach its steady state value fairly rapidly. This is something the user must evaluate on a case by case basis. For the runs presented here, 5 seconds was quite adequate. One more comment is in order. When making initialization runs, it is often necessary to use a lower integration increment and/or a higher order integration scheme than in the simulation runs. The reason is the elements of the P matrix often undergo wild perturbations, before settling out, when all the elements are initialized to zero.

A.8.9 Option 21

This option generates time histories of the means and covariances. The example presented here asks for a 20 second time history using Adams integration. The covariance matrix will be printed out at the initial time point (t = 0) and every 20 seconds. The output file is TAPE10.

After the call to SETUP, before the integration process begins, the elements of segment eight will be output. This was done to check on the parameters associated with the airwake calculations. It is not necessary to output anything here. But often, the user desires to know some parameter values but does not want to take up space on the output file. This is a convenient place to look at the values of such parameters.

For a given stepsize, Adams integration is three times faster than the third order Runge-Kutta and four times faster than the fourth order. However, the Adams integration stepsize will normally have to be lower than the Runge-Kutta stepsizes to obtain the same degree of accuracy. We have found the stepsize change does not offset the speed advantage; and for production running, Adams integration is preferable. As the user modifies these routines and/or treats new problems, he should spot check his integration to confirm the accuracy of the simulation. Integration problems normally manifest themselves as time history divergence, indefinite parameter values, or infinite parameter values.

A.8.10 Option 14

This option causes the output file to be tabbed according to the instructions stored by Option 11.

### A.8.11 Option 18

For some runs, the user may desire CalComp plots as well as tabbed output. The final option in this setup directs the plotting of 15 parameters from the output file. Normally one does not plot in the same run that generates the output file. It is difficult to know a priori good scales for the plots. The scales presenting these data were selected after having seen a tab output of the desired parameters.

A good description of the input required by the plot package has already been presented in Section A.5.2. The best approach to setting up plot instructions is to lay out the desired axes on regular graph paper, and use the grids to develop the distances for pen movement, etc.

## A.9 Discussion of an Input Deck for the Optimal Pilot Model Simulation

The purpose of this section is to lead the prospective user of VOLAR through a sample input deck for the optimal pilot-model simulation. The user should be familiar with Section A.5 which discusses the main program and its options. The discussion here will focus on the necessary flow of options to generate a time history and point out any special inputs that might not be obvious to the new user. This input deck is identical to the one which generated the 20 second sea state 5 time histories appearing in Figure 26.

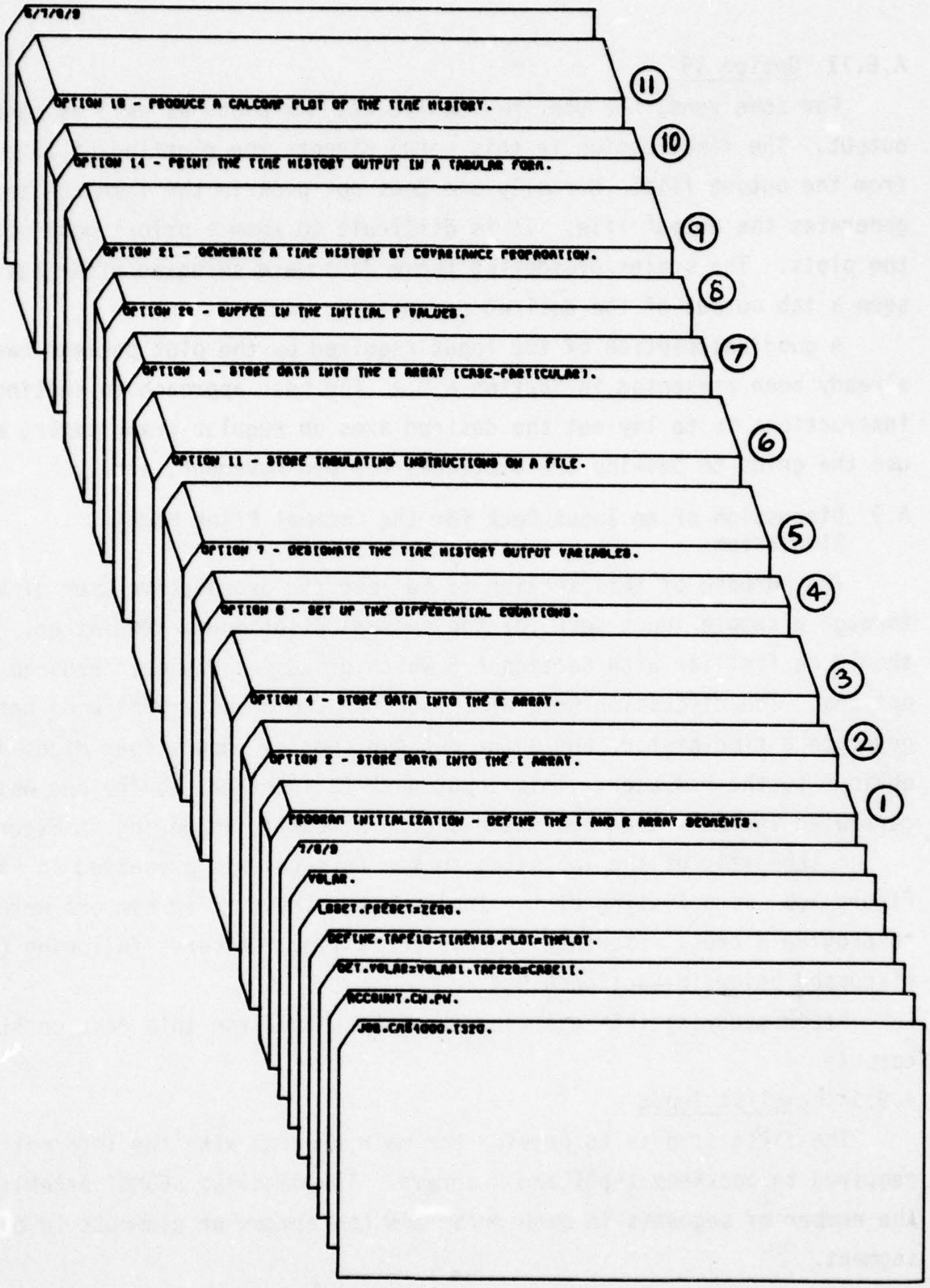
A schematic of the job setup to run this case is presented in Figure A.8. Figure A.9 is a listing of the input deck. The circled numbers were added to provide a cross reference to this text; i.e. the cards following ④ are discussed below in Section A.9.4.

After studying this example, the user should run this case on his computer.

### A.9.1 Namelist Input

The first step is to provide the main program with the information required to bookkeep the I and R arrays. The namelist SEGMNT establishes the number of segments in each array and the number of elements in each segment.

The namelist SEGMNT is the one and only mandatory input. All other inputs are either user selected options or input required by the chosen option.



```
6/7/8/9
OPTION 18 - PRODUCE A CALCOMP PLOT OF THE TIME HISTORY.
OPTION 14 - PRINT THE TIME HISTORY OUTPUT IN A TABULAR FORM.
OPTION 21 - GENERATE A TIME HISTORY BY COVARIANCE PROPAGATION.
OPTION 29 - BUFFER IN THE INITIAL P VALUES.
OPTION 4 - STORE DATA INTO THE R ARRAY (CASE-PARTICULAR).
OPTION 11 - STORE TABULATING INSTRUCTIONS ON A FILE.
OPTION 7 - DESIGNATE THE TIME HISTORY OUTPUT VARIABLES.
OPTION 6 - SET UP THE DIFFERENTIAL EQUATIONS.
OPTION 4 - STORE DATA INTO THE R ARRAY.
OPTION 2 - STORE DATA INTO THE I ARRAY.
PROGRAM INITIALIZATION - DEFINE THE I AND R ARRAY SEGMENTS.
7/8/9
VOLAR.
LDSET.PRESET=ZERO.
DEFINE.TAPE10=TIMEHIS.PLOT=THPLOT.
GET.VOLAR=VOLAR1.TAPE20=CASE11.
ACCOUNT.CN.PW.
JOB.CM54000.T320.
```

Figure A.6

```
① $SEGMNT NSEGI=7, NSEGR=143, NPRNT=1,
          NI(1)=10,0,0,14,14,6,
          NR(1)=6,17,17,26,18,11,37,66,9,37,
          NR(11)=14,18,6,10,0,6,19,0,0,10,
          NR(21)=10,10,10,10,10,0,6,6,6,6,
          NR(31)=6,6,6,6,6,6,6,6,6,6,
          NR(41)=6,6,6,6,6,6,6,0,289,
          NR(51)=289,289,44,16,50,50,75,75,75,75,
          NR(61)=75,75,6,6,6,6,6,6,6,6,
          NR(71)=6,6,6,6,6,6,6,6,6,6,
          NR(81)=36,24,42,49,28,1,1,1,1,24,
          NR(91)=16,1,1,1,1,1,1,1,1,1,
          NR(101)=1,1,1,1,1,1,12,6,6,6,
          NR(111)=6,6,6,6,6,6,6,6,6,6,
          NR(121)=6,6,6,6,6,6,6,6,6,6,
          NR(131)=6,6,6,6,10,10,10,10,10,4,
          NR(141)=4,4,4,
  $END
②   2         READ INTO I ARRAY
     5    5    0
     1    3    1    6  NSTATES, NPA, NOM, NGM
    11   17    4   11
     1    7    1   10  NPE, NPX, NOAW, NOINIT
     1    1    0    1
                       BLANK CARD FOR READ I
③   4         READ R
     5    5    0
     6    1    6    6  WEIGHT,G,IX,IY,IZ,IXZ
  16300.    32.174    1.        1.        1.        0.
     6    7    6    9  LM, WM, LTDM
  438.      46.75     348.
     7    9    7    9  TAUD
  0.2
     7   28    7   29  OMEGAV, KV
  2.        3.
     7   30    7   35  TAUA, K1, K2, KY, B1, B2
  0.1       1.12      2.83      .010      1.        2.
     7   36    7   37  TL1, TL2
  10.       2.
    13    1   13    6  TABV1  (V TABLE FOR AERO DATA)                     1.688
  0.        30.       50.       65.       80.       105.
    14    1   14   10  TABV2  (TIME TABLE FOR OPEN LOOP INPUTS)
  0.        2.        4.        6.        8.        10.       12.
  14.       16.       20.
    16    5   16    6  GAINDA, GAINDR
  1.        1.
    20    1   20   10  TABTC  (OPEN LOOP THETA)
  .13964    .13964    .13964    .13964    .13964    .13964    .13964
  .13964    .13964    .13964
   120    1  120    6  TYV
  -.034     -.063     -.088     -.104     -.120     -.138
   121    1  121    6  TYP
   0.       0.        0.        0.        0.        0.
   122    1  122    6  TYR
  -.225     -.240     -.24      -.235     -.235     -.215
   123    1  123    6  TYDA
  0.        -.006     -.015     -.026     -.039     -.065
   124    1  124    6  TYDR
  -.68      -.67      -.70      -.75      -.80      -.90
   125    1  125    6  TLV
  -.002     -.0144    -.0197    -.0204    -.0184    -.0104
   126    1  126    6  TLP
  -.13      -.42      -.62      -.79      -1.0      -1.38
```

Figure A.7

```
     127      1  127     6  TLR
    .015         .15        .24         .31         .375        .49
     128      1  128     6  TLDA
    .5           .5         .5          .5          .5          .5
     129      1  129     6  TLDR
    -.06         -.065      -.075       -.08        -.095       -.13
     130      1  130     6  TNV
    -.0036       -.0021     -.0010      0.          .0014       .0047
     131      1  131     6  TNP
    -.005        -.032      -.053       -.072       -.091       -.126
     132      1  132     6  TNR
    -.042        -.088      -.12        -.142       -.164       -.203
     133      1  133     6  TNDA
    .03          .03        .031        .033        .035        .040
     134      1  134     6  TNDR
    .225         .235       .243        .248        .255        .265
     135      1  135    10  TABUB
    65.869       61.254     56.640      52.025      47.410      42.796      38.181
    33.566       28.952     28.952
     136      1  136    10  TABWB
    9.257        8.608      7.96        7.311       6.663       6.014       5.366
    4.717        4.069      4.069
     137      1  137    10  TXAPP
    0.           128.372    247.425     357.157     457.57      548.662     630.434
    702.887      766.02     882.964
     138      1  138    10  TZAPP
    -50.         -50.       -50.        -50.        -50.        -50.        -50.
    -50.         -50.       -50.
     139      1  139    10  TXSP
    298.24       356.712    415.185     473.657     532.13      590.602     649.07
    707.547      766.02     882.964
     140      1  140     4  TDAIN
    -5.          -.9        .9          5.
     141      1  141     4  TDAOUT
    -.9          -.9        .9          .9
     142      1  142     4  TDRIN
    -5.          -.532      .532        5.
     143      1  143     4  TDROUT
    -.532        -.532      .532        .532
                            BLANK CARD FOR READ R
④      6            SETUP DIFFERENTIAL EQUATIONS
       4      1
       2     11    2    17  VDOT,PDOT,RDOT,YAPPDOT,PHIDOT,PSIDOT,YSPDOT
      12     15   12    18  DA1D,DA2D,DR1D,DR2D
                            BLANK CARD TO TERMINATE DERIVATIVES
       5      1
       3     11    3    17  VB, PB, RB, YAPP, PHI, PSI, YSP
      12     11   12    14  DA1,DA2,DR1,DR2
                            BLANK CARD TO TERMINATE STATES
       6      1
      52      1   51     1  PDOT, P
                            BLANK CARD
       6      3
     100      1   99     1  PED, PE
                            BLANK CARD
       6      5
     104      1  103     1  PXHATD, PXHAT
                            BLANK CARD, END OF OPTION 6
⑤      7            DESIGNATE OUTPUT VARIABLES
       1      1    1     1  TIME
       8      1    8     2  ALT, VAIR
       3      5    3     6  XAPP, ZAPP
       3     14    3    14  YAPP
       3     17    3    17  YSP
       3     15    3    16  PHI, PSI
      12      7   12     8  DA, DR
```

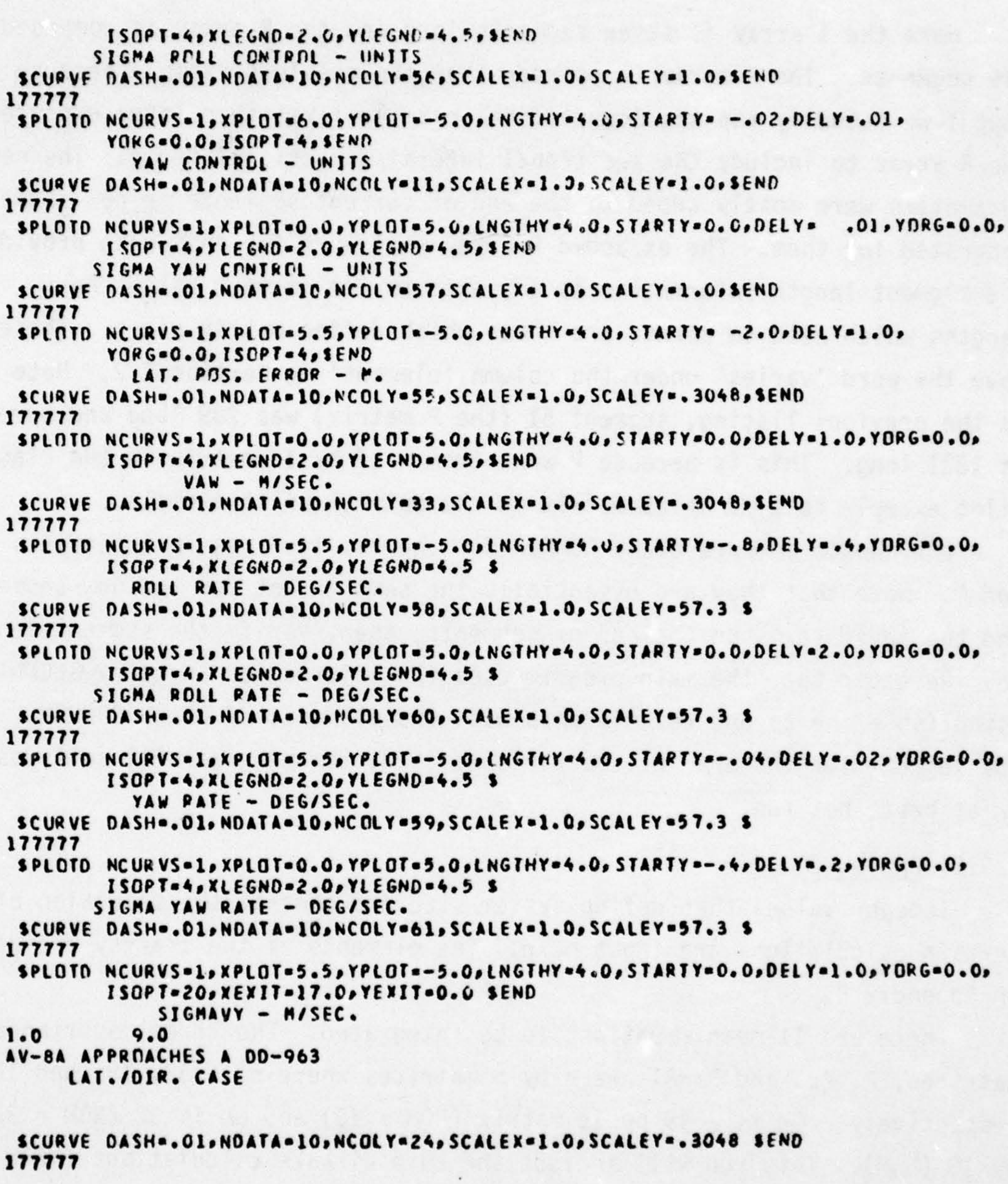
Figure A.7 (cont'd)

```
     16    3   16    4   SIGDA, SIGDR
      3   11    3   11   VB
      3    1    3    2   UB, WB
      8   27    8   29   XM, YM, ZM
      8   30    8   32   PSIA, THETAA, PHIA
      8   33    8   35   SIGMAVX, SIGMAVY, SIGMAVZ
      8   39    8   42   UWIND, UMEAN, UR, UAW
      8   43    8   46   VWIND, VMEAN, VR, VAW
      8   47    8   50   WWIND, WMEAN, WR, WAW
     55    1   55   17   SIGMAS OF THE STATES
     11    9   11    9   ERY
     16    1   16    2   SIGDAP, SIGDRP
      3   12    3   13   PB, RB
     55    2   55    3   SIGPB, SIGRB
                         BLANK CARD TO TERMINATE OPTION 7
⑥   11        STORE TABBING INSTRUCTIONS
      2    0
      9
     10    1   TIME
     10    2   ALT
     10    3   VA-KTS                                                      .5924
     10    8   PHI                                                        57.3
     10    9   PSI                                                        57.3
     10    4   XAPP
     10    6   YAPP
     10    7   YSP
     10   55   ERY
     10
     10    1   TIME
     10   14   VB
     10   30   VWIND
     10   31   VMEAN
     10   33   VAW
     10   24 SIGMAVY
     10   10   DA
     10   11   DR
     10   12  SIGDA
     10   13  SIGDR
     10
     10    1   TIME
     10   38  SIGV
     10   39 SIGP-DEG                                                      57.3
     10   40 SIGR-DEG                                                      57.3
     10   41  SIGPHI                                                       57.3
     10   42  SIGPSI                                                       57.3
     10   43  SIGY
     10   20  PSIA                                                         57.3
     10   21  THETAA                                                       57.3
     10   22  PHIA                                                         57.3
      9
     10    1   TIME
     10   56  SIGDAP
     10   57   SIGDRP
     10   12  SIGDA
     10   13  SIGDR
     10   58    PB
     10   59    RB
     10   60   SIGPB
     10   61   SIGRB
                        BLANK CARD TO TERMINATE OPTION 11
⑦     4        READ R   (CASE-PARTICULAR INPUT)
      5    5    0
      8   14    8   14   VAMB                                              1.688
   20.
      8   15    8   15   PSIAMB                                           .01745329
   150.
```

Figure A.7 (Cont'd)

```
      8   10    8   10  V5  (SHIP SPEED)                                 1.688
   20.
      8   11    8   11  PSI5 ((SHIP HEADING)                            .01745329
   30.
      8    3    8    5  UAS, VAS, WAS
   74.71     -7.012      10.495
      3   15    3   16  PHI, PSI                                        .01745329
   -1.         0.
      5   10    5   12  SUMFYO, SUMLG, SUMNO
   290.41      0.          0.
      2   17    2   17  YSP
   0.
      2   14    2   14  YAPP
   0.
                        BLANK CARD TO TERMINATE OPTION 4
 ⑧   28         BUFFER IN INITIAL P VALUES
      0
     51    1   51  289   P
                        BLANK CARD
 ⑨   21         COVARIANCE PROPAGATION
      *****************************
      **         AV-8A           **
      **    35 KT WOD, LAT/DIR   **
      *****************************
      5    5   10    3    0
      1    3    1    6 DTIME, DTOUT, DTOUT2, TMAX
  0.0125     0.2         20.0       20.0
                        BLANK CARD FOR READ R
      8    1    8   66  PRINT SEGMENT 8
                        BLANK CARD FOR WRITE R
 ⑩   14       TAB THE OUTPUT
      2       TAB INSTRUCTIONS STORED ON FILE 2
 ⑪   18        PRODUCE CALCOMP PLOTS
      5       1
  CAL34       PLOT
     15
  $PLOTD NCURVS=2,XPLOT=.75,YPLOT=0.0,ANGLE=0.0,LNGTHX=4.0,STARTX=0.0,
         DELX=5.0,XORG=0.0,LNGTHY=4.0,STARTY=00.0,DELY=40.0,YORG=0.0,
         ISOPT=6 ,XLEGND=2.0,YLEGND=1.0 $END
                TIME - SEC.
             LATERAL POS. - M.
  $CURVE DASH=.01,NDATA=10,NCOLX=1,NCOLY=6,LINTYP=0,SCALEX=1.0,SCALEY=.3048 $END
 177777
  $CURVE DASH=.01,NDATA=10,NCOLY=7,$END
 170360    COMMANDED
  $PLOTD NCURVS=1,XPLOT=0.0,YPLOT=5.0,LNGTHY=4.0,STARTY=0.0,DELY= 1.0,YORG=0.0,
         ISOPT=4,XLEGND=2.0,YLEGND=4.5,$END
           SIGMA LAT. POS. - M.
  $CURVE DASH=.01,NDATA=10,NCOLY=43,SCALEX=1.0,SCALEY=.3048 $END
 177777
  $PLOTD NCURVS=1,XPLOT=5.5,YPLOT=-5.0,LNGTHY=4.0,STARTY=-4.0,DELY=2.0,YORG=0.0,
         ISOPT=4,XLEGND=2.0,YLEGND=3.5 $END
             BANK ANGLE - DEG.
  $CURVE DASH=.01,NDATA=10,NCOLY=8,SCALEX=1.0,SCALEY=57.3 $END
 177777
  $PLOTD NCURVS=1,XPLOT=0.0,YPLOT=5.0,LNGTHY=4.0,STARTY=0.0,DELY= 2.0,YORG=0.0,
         ISOPT=4,XLEGND=2.0,YLEGND=4.5,$END
             SIGMA PHI - DEG.
  $CURVE DASH=.01,NDATA=10,NCOLY=41,SCALEX=1.0,SCALEY=57.3 $END
 177777
  $PLOTD NCURVS=1,XPLOT=5.5,YPLOT=-5.0,LNGTHY=4.0,STARTY=-0.2,DELY=0.1,YORG=0.0,
         ISOPT=4,$END
           ROLL CONTROL - UNITS
  $CURVE DASH=.01,NDATA=10,NCOLY=10,SCALEX=1.0,SCALEY=1.0,$END
 177777
  $PLOTD NCURVS=1,XPLOT=0.0,YPLOT=5.0,LNGTHY=4.0,STARTY=0.0,DELY=.20,YORG=0.0,
```

Figure A.7 (Cont'd)



```
         ISOPT=4,XLEGND=2.0,YLEGND=4.5,$END
        SIGMA ROLL CONTROL - UNITS
 $CURVE DASH=.01,NDATA=10,NCOLY=56,SCALEX=1.0,SCALEY=1.0,$END
177777
 $PLOTD NCURVS=1,XPLOT=6.0,YPLOT=-5.0,LNGTHY=4.0,STARTY= -.02,DELY=.01,
         YORG=0.0,ISOPT=4,$END
           YAW CONTROL - UNITS
 $CURVE DASH=.01,NDATA=10,NCOLY=11,SCALEX=1.0,SCALEY=1.0,$END
177777
 $PLOTD NCURVS=1,XPLOT=0.0,YPLOT=5.0,LNGTHY=4.0,STARTY=0.0,DELY=  .01,YORG=0.0,
         ISOPT=4,XLEGND=2.0,YLEGND=4.5,$END
        SIGMA YAW CONTROL - UNITS
 $CURVE DASH=.01,NDATA=10,NCOLY=57,SCALEX=1.0,SCALEY=1.0,$END
177777
 $PLOTD NCURVS=1,XPLOT=5.5,YPLOT=-5.0,LNGTHY=4.0,STARTY= -2.0,DELY=1.0,
         YORG=0.0,ISOPT=4,$END
           LAT. POS. ERROR - M.
 $CURVE DASH=.01,NDATA=10,NCOLY=55,SCALEX=1.0,SCALEY=.3048,$END
177777
 $PLOTD NCURVS=1,XPLOT=0.0,YPLOT=5.0,LNGTHY=4.0,STARTY=0.0,DELY=1.0,YORG=0.0,
         ISOPT=4,XLEGND=2.0,YLEGND=4.5,$END
              VAW - M/SEC.
 $CURVE DASH=.01,NDATA=10,NCOLY=33,SCALEX=1.0,SCALEY=.3048,$END
177777
 $PLOTD NCURVS=1,XPLOT=5.5,YPLOT=-5.0,LNGTHY=4.0,STARTY=-.8,DELY=.4,YORG=0.0,
         ISOPT=4,XLEGND=2.0,YLEGND=4.5 $
           ROLL RATE - DEG/SEC.
 $CURVE DASH=.01,NDATA=10,NCOLY=58,SCALEX=1.0,SCALEY=57.3 $
177777
 $PLOTD NCURVS=1,XPLOT=0.0,YPLOT=5.0,LNGTHY=4.0,STARTY=0.0,DELY=2.0,YORG=0.0,
         ISOPT=4,XLEGND=2.0,YLEGND=4.5 $
        SIGMA ROLL RATE - DEG/SEC.
 $CURVE DASH=.01,NDATA=10,NCOLY=60,SCALEX=1.0,SCALEY=57.3 $
177777
 $PLOTD NCURVS=1,XPLOT=5.5,YPLOT=-5.0,LNGTHY=4.0,STARTY=-.04,DELY=.02,YORG=0.0,
         ISOPT=4,XLEGND=2.0,YLEGND=4.5 $
           YAW RATE - DEG/SEC.
 $CURVE DASH=.01,NDATA=10,NCOLY=59,SCALEX=1.0,SCALEY=57.3 $
177777
 $PLOTD NCURVS=1,XPLOT=0.0,YPLOT=5.0,LNGTHY=4.0,STARTY=-.4,DELY=.2,YORG=0.0,
         ISOPT=4,XLEGND=2.0,YLEGND=4.5 $
        SIGMA YAW RATE - DEG/SEC.
 $CURVE DASH=.01,NDATA=10,NCOLY=61,SCALEX=1.0,SCALEY=57.3 $
177777
 $PLOTD NCURVS=1,XPLOT=5.5,YPLOT=-5.0,LNGTHY=4.0,STARTY=0.0,DELY=1.0,YORG=0.0,
         ISOPT=20,XEXIT=17.0,YEXIT=0.0 $END
              SIGMAVY - M/SEC.
1.0       9.0
AV-8A APPROACHES A DD-963
      LAT./DIR. CASE


 $CURVE DASH=.01,NDATA=10,NCOLY=24,SCALEX=1.0,SCALEY=.3048 $END
177777
```

Figure A.7 (Cont'd)

Here the I array is seven segments long and the R array is composed of 119 segments. The R array is shorter than the previous example because at Vought we actually ran the longitudinal example first then later expanded the R array to include the additional lateral/directional terms. The new parameters were mostly added to the end of current segments or new segments generated for them. The expanded R array will work for this case provided the segment length information is adjusted to the correct values here. The lengths which need to change are those which define matrix sizes. These have the word 'varies' under the column 'element' in Section E.2. Note that in the previous listing, segment 51 (the P matrix) was 289 long and here it is 1521 long. This is because P went from a 17 by 17 matrix in the classical pilot example to a 39 by 39 matrix in the optimal pilot example.

One should compare blank COMMON for the two listings in Appendices B and C. Note that they are essentially the same except for the new segments and the added terms on the end of segments; then, verify the segment lengths.

Remember that the main program uses the information input by SEGMNT to establish a one to one relationship with the elements of blank COMMON. If the segment lengths are incorrectly specified, the program will self destruct; or at best, not run.

### A.9.2 Option 2

Integer values that define system size and control the selection of certain calculations are input here. The elements of the I array are defined in Appendix E.

There are 11 mean equations to be integrated. The three covariance matrices, P, PE, and PXHAT are n by n matrices where n is 39, 18, and 18 respectively. QM is a 15 by 15 matrix (NQM = 15) and GM is 32 (NGM = 32) by 15 (NQM). This run will include the ship airwake calculations (NØAW = 0) and is not an initialization run (NØINIT = 1).

### A.9.3 Option 4

Required values of the R array are input next. At Vought, we normally input fixed geometric and aerodynamic properties here; inputting case dependent information later in the deck. At the beginning of job execution, the control card 'LDSET,PRESET = ZERØ.' initializes core to zero; therefore parameters not initialized through an Option 4 begin with a value of zero.

Note that the value of IY is 1; obviously not a realistic inertia. The 1 is used because the inertias are not needed to generate accelerations (because of dimensional derivatives) but inertia does appear as a denominator in SETUP. The numerator term is zero so anything in the denominator will work. This is all related to the calculation of forces and moments in DEQU, where the total forces and moments that drive the mean equations must be obtained from a reference condition and perturbation forces and moments.

All the tables that define the open loop inputs, dimensional derivatives, and optimal pilot feedback gains are input here. They are consistent with the independent variable arrays TABV1 and TABV2.

The ship geometry terms are for a DD-963 and the aerodynamic derivatives are from Reference 15. The optimal pilot feedback gains were determined consistent with the derivation in Section 7.

Note the breakpoints in TABV1 (segment 13, elements 1 - 6). The only two 'legitimate' points are 35. and 56.6 knots. The data tables that are a function of airspeed are input with the same value at 0 as 35 knots and the same values for 60., 61., and 62. knots as 56.6 knots. This was done to fill up the tables, and in the case of 0 knots, to keep the computer from extrapolating to speeds lower than 35 knots. Here the simulation uses 35 knots data for any airspeed that drops below 35 knots. Thirty-five knots is the lowest airspeed the airplane should have (35 is WOD speed) and the 56.6 knots was a value initially selected for the beginning of the time history. The pilot feedback gains and the dimensional derivatives are assumed to vary linearly between these speeds. To cut down on run time, the airplane was moved closer to the ship, to start the simulation, and the initial airspeed became 44.7 knots. There was no requirement to change the data tables because the table look-up routine will give values for 44.7 knots just as it will for all airspeeds between 35 knots and 56.6 knots.

### A.9.4 Option 6

The user next specifies the variables that are to be integrated and the locations which contain the integrated values. There is no restriction on the number of variables one desires to integrate as long as the fourth and fifth I array segments are long enough to keep all the R array indices.

Also note that the number of mean equations should equal NSTATES (I array segment 1, element 3).The integration subroutines will only integrate the first NSTATES derivatives specified in the first part of Option 6. When setting up matrices to be integrated it is only necessary to define the R array location of the first element. The number of matrix elements integrated is determined internally from the matrix size information read in previously (Option 2).

Option 6 expects location information for all three pairs of matrices (PDOT and P, etc.) whether the user intends to integrate these or not. A good example of this is the classical pilot model. Refer to Sections A.8.2 and A.8.4 for additional comments on this matter.

### A.9.5 Option 7

The variables specified here appear on the output file. Their selection is totally up to the user. All of the output features (tabbing, plotting, etc.) access the file containing the Option 7 specified variables.

### A.9.6 Option 11

The variables to be tabbed are user defined. Here we have attempted to tabulate all the key parameters for interpreting the performance of a given task.

### A.9.7 Option 4

The case-particular input goes here; i.e., the things necessary to define the environment (wind speed, etc.) and the initial conditions of the airplane and ship.

The initial components of airspeed (segment 8, elements 3 - 5) and initial forces and moment (segment 5, elements 1 - 3) are required. The airspeed requirement could be relaxed, if desired, according to the discussion of Section A.8.7. If the equations describing the means in DEQU were perturbation equations or it was not desired to integrate the means then the initial forces and moment requirement would not longer be valid.

The ship motion inputs KZS, ZETAZS, and WNZS were obtained from Section 9 of this report. The value of KZS is the value of $K_Z$ from the table multiplied by $\omega_n$ squared. ZETAZS and WNZS are the damping, $\zeta$, and natural frequency, $\omega_n$, presented in Table 9 of Section 9.

### A.9.8 Option 28

This option reads data stored from a previous run. It is used here to initialize the matrices P, PE, PXHAT, VU, and VY. A good discussion of the reason for this initialization appears in Section A.8.8 and will not be repeated here.

The important thing is that this setup expects a TAPE28 to be ATTACH'ed (GET'ed) to this job; and for this file to contain numerical values for all the elements of the above mentioned matrices.

To generate the TAPE28 file for initialization the user makes the following changes to the run deck. In Option 2 the value of NSTATES is reduced by one and the value of NØINIT is set to -1. The cards setting RCD as an integrand and RC as the integrator's output should be removed from Option 6. In one of the Option 4's, input RCD (segment 11, element 2) with the value -37.28 (its t = 0 value). Run a 5 second time history using third or fourth order Runge-Kutta integration. An integration stepsize of .025 is adequate. Following the time history (Option 21) call Option 28 and store the desired matrices; remembering to include the necessary control cards to catalog this file for future use.

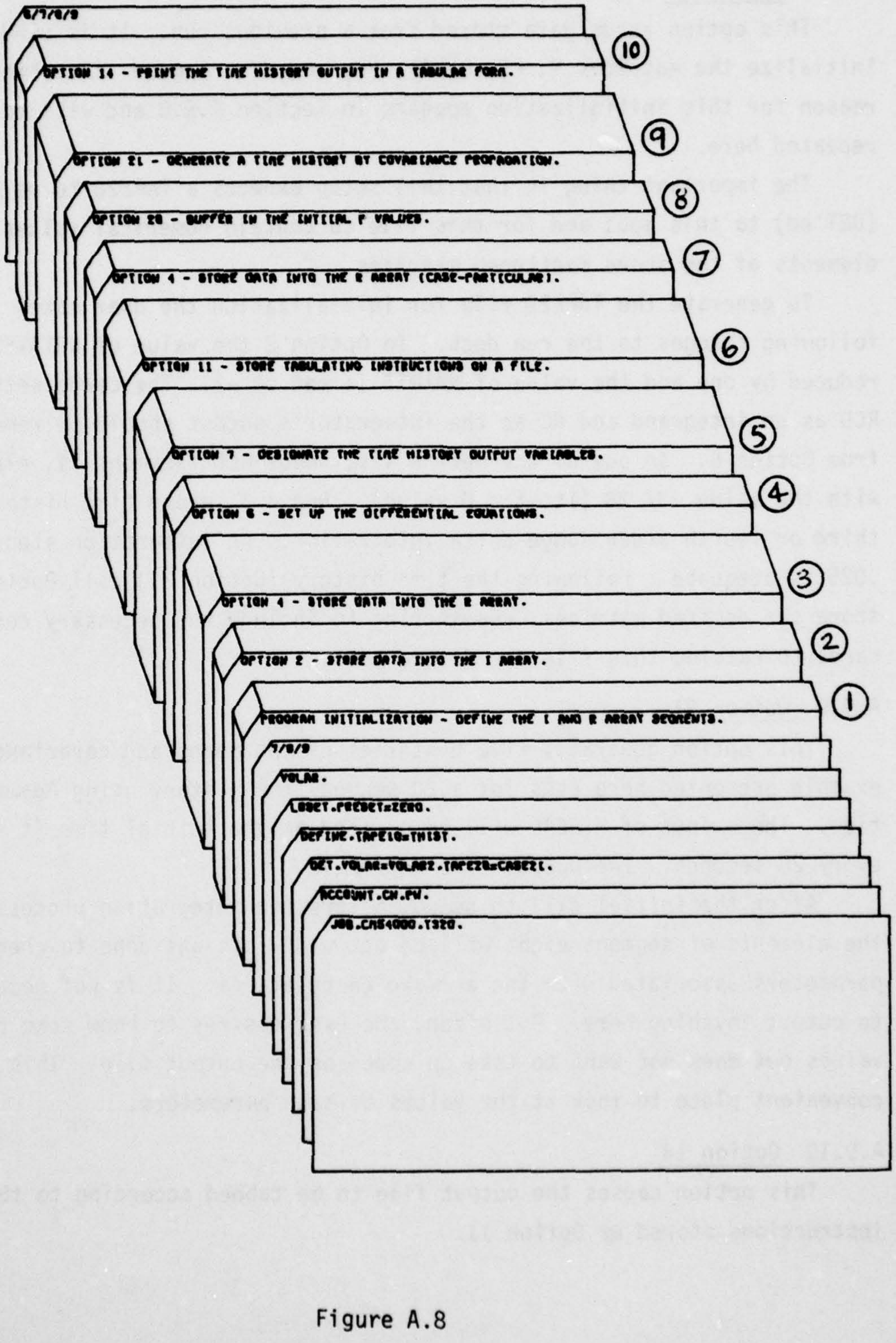
### A.9.9 Option 21

This option generates time histories of the means and covariances. The example presented here asks for a 20 second time history using Adams integration. The output of MISCAL will be printed at the initial time (t = 0) and every 20 seconds. The output file is TAPE10.

After the initial call to setup, before the integration process begins the elements of segment eight will be output. This was done to check on the parameters associated with the airwake calculations. It is not necessary to output anything here. But often, the user desires to know some parameter values but does not want to take up space on the output file. This is a convenient place to look at the values of such parameters.

### A.9.10 Option 14

This option causes the output file to be tabbed according to the instructions stored by Option 11.



```
6/7/8/9
OPTION 14 - PRINT THE TIME HISTORY OUTPUT IN A TABULAR FORM.
OPTION 21 - GENERATE A TIME HISTORY BY COVARIANCE PROPAGATION.
OPTION 28 - BUFFER IN THE INITIAL P VALUES.
OPTION 4 - STORE DATA INTO THE R ARRAY (CASE-PARTICULAR).
OPTION 11 - STORE TABULATING INSTRUCTIONS ON A FILE.
OPTION 7 - DESIGNATE THE TIME HISTORY OUTPUT VARIABLES.
OPTION 6 - SET UP THE DIFFERENTIAL EQUATIONS.
OPTION 4 - STORE DATA INTO THE R ARRAY.
OPTION 2 - STORE DATA INTO THE I ARRAY.
PROGRAM INITIALIZATION - DEFINE THE I AND R ARRAY SEGMENTS.
7/8/9
VOLAR.
LDSET.PRESET=ZERO.
DEFINE.TAPE10=THIST.
GET.VOLAR=VOLAR2.TAPE20=CASE21.
ACCOUNT.CN.PW.
JOB.CM54000.T320.
```

Figure A.8

```
(1) $SEGMNT NSEGI=7, NSEGR=119, NPRNT=1,
            NI(1)=10,0,0,14,14,6,
            NR(1)=6,10,10,16,9,11,27,66,7,22,
            NR(11)=8,6,6,10,7,7,19,0,0,10,
            NR(21)=10,10,10,10,10,0,6,6,6,6,
            NR(31)=6,6,6,6,6,6,6,6,6,6,
            NR(41)=6,6,6,6,6,6,6,6,0,1521,
            NR(51)=1521,1521,480,225,50,50,75,75,75,75,
            NR(61)=75,75,6,6,6,6,6,6,6,6,
            NR(71)=6,6,6,6,6,6,6,6,6,6,
            NR(81)=49,21,56,64,40,36,42,36,42,45,
            NR(91)=9,25,9,36,36, 9,324,324,324,324,
            NR(101)=108,324,324,324,324,9,12,6,6,6,
            NR(111)=6,6,6,6,6,6,6,6,6,
    $END
(2)   2        READ INTO I ARRAY
      5    5    0
      1    3    1    6   NSTATES, NPA, NOM, NGM
     11   39   15   32
      1    7    1   10   NPE, NPX, NOAW, NOINIT
     18   18    0    1
                         BLANK CARD FOR READ I
(3)   4        READ INTO THE R ARRAY
      5    5    0
      6    1    6    6   WEIGHT,G,IX,IY,IZ,IXZ
    16300.     32.174     0.         1.         0.         0.
      6    7    6    9   LM, WM,LTOM
    438.0      46.75      348.0
      7    1    7    6   OMEGAU,OMEGAW,KU,KW,KFRPM,KCON
    2.         2.         3.         3.         1.         0.
      7    7    7    9   TAUENG,TAUCON,TAUD
    .2         .1         .4
     13    1   13    6   TABV1 (V TABLE FOR AERO DATA)                        1.688
    0.0        35.0       56.6       60.0       61.0       62.0
     14    1   14   10   TABV2 (T TABLE FOR OPEN LOOP CNTRLS)
    0.         2.         4.         6.         8.         10.        12.
    14.        16.        20.
     15    1   15    7   TABEZP
    -10000.    -1000.     -100.      0.         100.       1000.      10000.
     16    1   16    7   TABEZ
    -10000.    -1000.     -100.      0.         100.       1000.      10000.
     20    1   20   10   TABTC
    .13963     .13963     .13963     .13963     .13963     .13963     .13963     THETAC
    .13963     .13963     .13963                                                 THETAC
     21    1   21   10   TRPMOL
    0.         0.         0.         0.         0.         0.         0.          RPM 1
    0.         0.         0.                                                      RPM 2
     22    1   22   10   TCONOL
    0.         0.         0.         0.         0.         0.         0.          CON 1
    0.         0.         0.                                                      CON 2
     23    1   23   10   TDEOL
    0.         0.         0.         0.         0.         0.         0.          DE 1
    0.         0.         0.                                                      DE 2
     24    1   24   10   TABR
    0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0
     25    1   25   10   TABRD                                                1.69
    0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0
     27    1   27    6   TXU
    -.044      -.044      -.044      -.044      -.044      -.044                XU
     28    1   28    6   TXW
    .0009      .0009      .00636     .00636     .00636     .00636               XW
```

Figure A.9

```
   29     1    29     6   TXQ
.035        .035       .0509       .0509      .0509      .0509              XQ
   30     1    30     6   TXRPM
.2905       .2905      .2457       .2457      .2457      .2457              XRPM
   31     1    31     6   TXCDN
0.          0.         0.          0.         0.         0.                 XCDN
   32     1    32     6   TXPIGV
0.          0.         0.          0.         0.         0.                 XPDIGV
   33     1    33     6   TXDE
-.1495      -.1495     -.1424      -.1424     -.1424     -.1424             XDE
   34     1    34     6   TZU
-.0307      -.0307     -.0663      -.0663     -.0663     -.0663             ZU
   35     1    35     6   TZW
-.1425      -.1425     -.2148      -.2148     -.2148     -.2148             ZW
   36     1    36     6   TZQ
-.3175      -.3175     -.4308      -.4308     -.4308     -.4308             ZQ
   37     1    37     6   TZRPM
-2.4375     -2.4375    -2.322      -2.322     -2.322     -2.322             ZRPM
   38     1    38     6   TZCDN
0.          0.         0.          0.         0.         0.                 ZCDN
   39     1    39     6   TZPIGV
0.          0.         0.          0.         0.         0.                 ZPDIGV
   40     1    40     6   TZDE
-.3388      -.3388     -.3328      -.3328     -.3328     -.3328             ZDE
   41     1    41     6   TMU
-.0012      -.0012     -.00226     -.00226    -.00226    -.00226            MU
   42     1    42     6   TMW
.00453      .00453     .00316      .00316     .00316     .00316             MW
   43     1    43     6   TMWD
0.          0.         0.          0.         0.         0.                 MWD
   44     1    44     6   TMQ
-.1285      -.1285     -.1736      -.1736     -.1736     -.1736             MQ
   45     1    45     6   TMRPM
-.036       -.036      -.036       -.036      -.036      -.036              MRPM
   46     1    46     6   TMCDN
0.          0.         0.          0.         0.         0.                 MCDN
   47     1    47     6   TMPIGV
0.          0.         0.          0.         0.         0.                 MPDIGV
   48     1    48     6   TMDE
.2355       .2355      .2383       .2383      .2383      .2383              MDE
   63     1    63     6   TKDEU
-9.064      -9.064     -9.027      -9.027     -9.027     -9.027
   64     1    64     6   TKDEW
-1.729      -1.729     -1.677      -1.677     -1.677     -1.677
   65     1    65     6   TKDEQ
214.67      214.67     213.16      213.16     213.16     213.16
   66     1    66     6   TKDET
368.23      368.23     387.05      387.05     387.05     387.05
   67     1    67     6   TKDEX
-4.289      -4.289     -4.29       -4.29      -4.29      -4.29
   68     1    68     6   TKDEZ
-1.444      -1.444     -1.447      -1.447     -1.447     -1.447
   69     1    69     6   TKDEN
-.6123      -.6123     -.5986      -.5986     -.5986     -.5986
   70     1    70     6   TKDEDE
9.9987      9.9987     10.         10.        10.        10.
   71     1    71     6   TKDEDT
-.2425      -.2425     -.2366      -.2366     -.2366     -.2366
   72     1    72     6   TKDTU
33.44       33.44      36.17       36.17      36.17      36.17
   73     1    73     6   TKDTW
-19.524     -19.524    -20.189     -20.189    -20.189    -20.189
   74     1    74     6   TKDTQ
-655.11     -655.11    -693.91     -693.91    -693.91    -693.91
   75     1    75     6   TKDTT
-409.81     -409.81    513.86      513.86     513.86     513.86
```

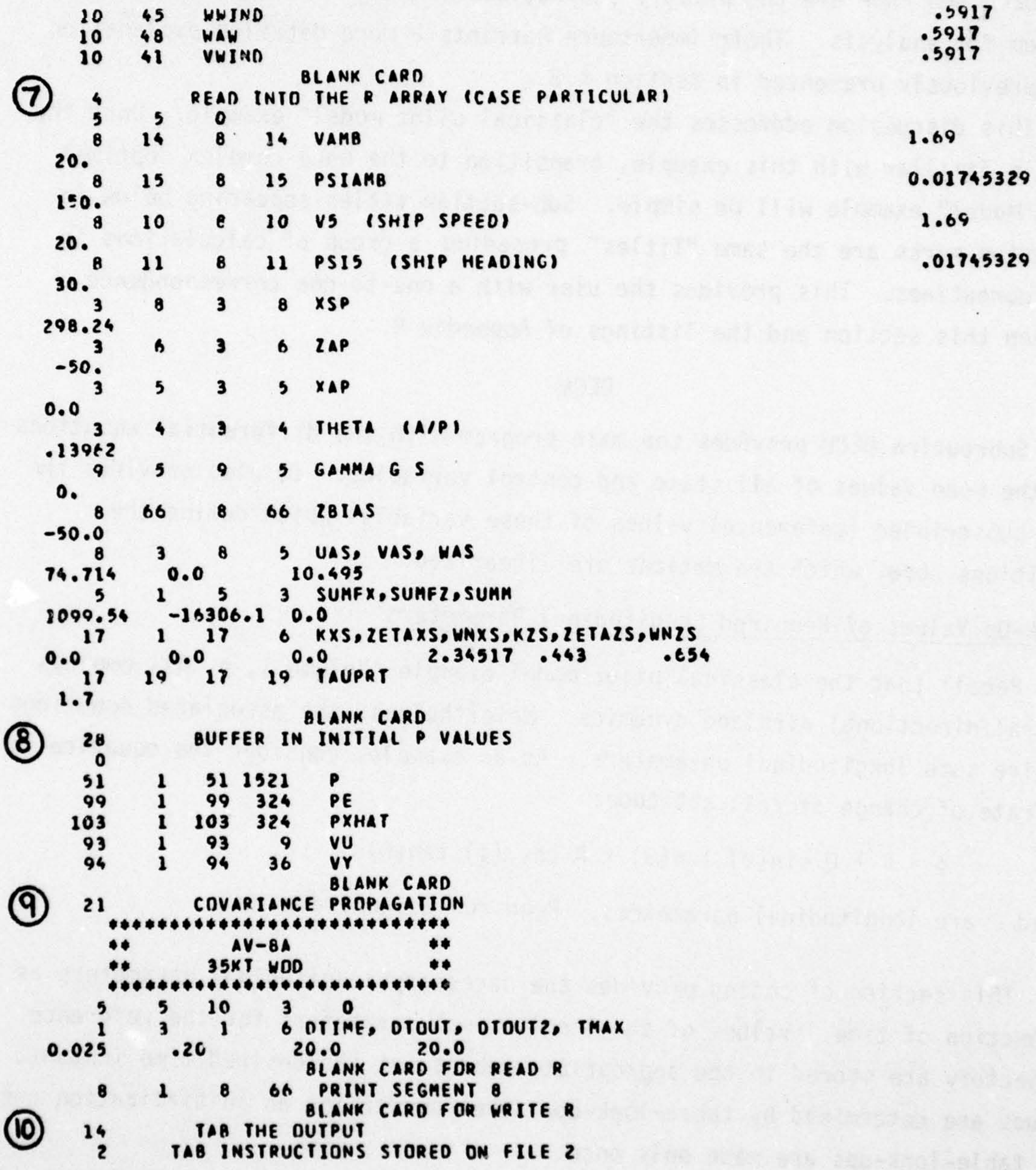
Figure A.9 (Cont'd)

```
      76      1   76     6   TKDTX
   13.34        13.34        14.05         14.05         14.05         14.05
      77      1   77     6   TKDTZ
   -39.627      -39.627      -41.653       -41.653       -41.653       -41.653
      78      1   78     6   TKDTN
   10.503       10.503       10.524        10.524        10.524        10.524
      79      1   79     6   TKDTDE
   -20.697      -20.697      -22.298       -22.298       -22.298       -22.298
      80      1   80     6   TKDTDT
   10.00        10.0         9.9985        9.9985        9.9985        9.9985
     108      1  108     6   TDEUR
   -.1684       -.1684       -.149         -.149         -.149         -.149
     109      1  109     6   TDEWR
   -.1993       -.1993       -.1723        -.1723        -.1723        -.1723
     110      1  110     6   TDEVX
   -.3552       -.3552       -.3428        -.3428        -.3428        -.3428
     111      1  111     6   TDEVXD
   -.2248       -.2248       -.2372        -.2372        -.2372        -.2372
     112      1  112     6   TDEVZ
   -.263        -.263        -.2329        -.2329        -.2329        -.2329
     113      1  113     6   TDEVZD
   -.04412      -.04412      -.0432        -.0432        -.0432        -.0432
     114      1  114     6   TDTUR
   .3245        .3245        .06174        .06174        .06174        .06174
     115      1  115     6   TDTWR
   -.19145      -.19146      -.6403        -.6403        -.6403        -.6403
     116      1  116     6   TDTVX
   .8613        .8613        .5995         .5995         .5995         .5995
     117      1  117     6   TDTVXD
   .68496       .68496       .7478         .7478         .7478         .7478
     118      1  118     6   TDTVZ
   -.3777       -.3777       -.9717        -.9717        -.9717        -.9717
     119      1  119     6   TDTVZD
   -.0884       -.0884       -.1678        -.1678        -.1678        -.1678
                             BLANK CARD FOR READ R
④      6         SETUP DIFFERENTIAL EQUATIONS
       4      1
       2      1    2     6   UDDT,WDOT,QDOT,TDOT,XAPPDOT,ZAPPDOT
       2      7    2     7   DFRPMD
       2      8    2     8   XSPDOT
      12      4   12     5   DED,DTD
      11      2   11     2   RCD
                             BLANK CARD TO TERMINATE DERIVATIVES
       5      1
       3      1    3     6   UB,WB,QB,THETA,XAPP,ZAPP
       3      7    3     7   DFRPM
       3      8    3     8   XSP
      12      1   12     2   DE,DT
      11      1   11     1   RC
                             BLANK CARD TO TERMINATE STATES
       6      1
      52      1   51     1   PDOT,P

       6      3
     100      1   99     1   PED, PE

       6      5
     104      1  103     1   PXHATD, PXHAT
                             BLANK CARD TO TERMINATE OPTION 6
⑤      7        DESIGNATE OUTPUT VARIABLES
       1      1    1     1 TIME
       8      1    8     2  ALT, VAIR
       3      4    3     4  THETA
       3      5    3     6  XAPP, ZAPP
      12      1   12     2  DE, DT
      12      3   12     3  DCON
```

Figure A.9 (Cont'd)

```
   3    1    3    3  UR, WB, GB
   8    6    8    6  ALPHA
   8   65    8   65  ZGS
   9    1    9    4  THETAC,FRPNOL,CONOL,DEOL
   9    6    9    6  ACTUAL RANGE
  55    4   55    6  SIG THETA, SIG XAP, SIG ZAP
  55    7   55    7  SIG FRPM
  55   17   55   17  SIG DT
  55   16   55   16  SIG DE
   3    7    3    7  DFRPM
  55   40   55   41  SIG EGS, SIG TD
   9    7    9    7  VAIRC
   8   27    8   29  XM, YM, ZM
   8   30    8   30  PSIA
   8   33    8   35  SIGMAVX, SIGMAVY, SIGMAVZ
   8   39    8   42  UWIND, UMEAN, UR, UAW
   8   43    8   46  VWIND, VMEAN, VR, VAW
   8   47    8   50  WWIND, WMEAN, WR, WAW
  56    6   56    6  SIGMA XZ
  11    1   11    2  RC, RCD
  56    4   56    5
  56    7   56    7
  56   16   56   17
  56   37   56   38
   3    8    3    8  XSP
                    BLANK CARD
⑥ 11        STORE TABRING INSTRUCTIONS
   2    0     NTAP, IPUNCH
   9
  10    1    TIME
  10    2    ALT
  10    3    VA                                                    .592417
  10    4    THETA                                                57.29578
  10    5    XAP
  10   14    ZGS                                                   -1.
  10    6    ZAP                                                   -1.
  10   50    RC
  10   59    XSP
   9
  10    1    TIME
  10    7     DE
  10    8     DT
  10   16    RPNOL
  10   17    CONOL
  10   18     DEOL
  10   19     RANGE
  10   26    DFRPM
  10    9    DCDN
   9
  10    1    TIME
  10   20 SIG THETA                                                 57.3
  10   21  SIG XAP
  10   22  SIG ZAP
  10   23 SIG FRPM
  10   24  SIG DT
  10   25  SIG DE
  10   49  SIG XZ
  10   28   SIG TD
  10
  10    1    TIME
  10   30     XM
  10   31     YM
  10   32     ZM
  10   33    PSIA                                                  57.3
  10   37    UWIND                                                 .5917
  10   40    UAW                                                   .5917
```

Figure A.9 (Cont'd)



```
   10   45   WWIND                                                .5917
   10   48   WAW                                                  .5917
   10   41   VWIND                                                .5917
                     BLANK CARD
⑦  4          READ INTO THE R ARRAY (CASE PARTICULAR)
    5    5    0
    8   14    8   14  VAMB                                        1.69
 20.
    8   15    8   15  PSIAMB                                      0.01745329
 150.
    8   10    e   10  V5  (SHIP SPEED)                            1.69
 20.
    8   11    8   11  PSI5  (SHIP HEADING)                        .01745329
 30.
    3    8    3    8  XSP
 298.24
    3    6    3    6  ZAP
 -50.
    3    5    3    5  XAP
 0.0
    3    4    3    4  THETA  (A/P)
 .13962
    9    5    9    5  GAMMA G S
 0.
    8   66    8   66  ZBIAS
 -50.0
    8    3    8    5  UAS, VAS, WAS
 74.714    0.0       10.495
    5    1    5    3  SUMFX,SUMFZ,SUMM
 1099.54   -16306.1  0.0
   17    1   17    6  KXS,ZETAXS,WNXS,KZS,ZETAZS,WNZS
 0.0       0.0       0.0          2.34517  .443      .654
   17   19   17   19  TAUPRT
  1.7
                     BLANK CARD
⑧  28         BUFFER IN INITIAL P VALUES
    0
   51    1   51 1521   P
   99    1   99  324   PE
  103    1  103  324   PXHAT
   93    1   93    9   VU
   94    1   94   36   VY
                     BLANK CARD
⑨  21         COVARIANCE PROPAGATION
      ******************************
      **         AV-8A            **
      **        35KT WOD          **
      ******************************
    5    5   10    3    0
    1    3    1    6 DTIME, DTOUT, DTOUT2, TMAX
 0.025     .20       20.0      20.0
                     BLANK CARD FOR READ R
    8    1    8   66  PRINT SEGMENT 8
                     BLANK CARD FOR WRITE R
⑩  14         TAB THE OUTPUT
    2       TAB INSTRUCTIONS STORED ON FILE 2
```

Figure A.9 (Cont'd)

## A.10 A Discussion of the Programmed Equations in Subroutines DEQU and PROP.

DEQU and PROP are the primary subroutines whereby the user defines his problem for analysis. Their importance warrants a more detailed explanation than previously presented in Section A.3.

This discussion addresses the "classical pilot model" example. Once the user is familiar with this example, transition to the more complex "optimal pilot model" example will be simple. Sub-section titles appearing below in quotation marks are the same "Titles" preceding a group of calculations in the subroutines. This provides the user with a one-to-one correspondence between this section and the listings of Appendix B.

### DEQU

Subroutine DEQU provides the main program with the differential equations for the mean values of all state and control variables. It also provides the zero subscripted (reference) values of these variables which define the conditions about which the motions are linearized.

### "Look-Up Values of Required Longitudinal Parameters"

Recall that the classical pilot model example (Volume I, p. 41) employs lateral/directional airplane dynamics. Nevertheless, the associated equations require some longitudinal parameters. As an example, consider the equation for rate of change of roll attitude:

$$\dot{\Phi} = P + Q \sin(\Phi) \tan(\Theta) + R \cos(\Phi) \tan(\Theta)$$

Q and $\Theta$ are longitudinal parameters. Required to generate $\dot{\Phi}$.

This section of coding provides the necessary longitudinal parameters as a function of time. Values of the longitudinal parameters for the reference trajectory are stored in the appropriate tables; at the desired time instant, values are determined by table-look-up. When performing an initialization run the table-lock-ups are made only once.

### "Miscellaneous Calculations"

Calculations performed here include:

(a) $\Theta = \Theta_c$. This sets airplane pitch attitude equal to the pitch attitude from the table-look-up of the previous section.

(b) Ship vertical position is set to zero (ZSP = 0).

(c) Perturbation values for roll rate and yaw rate are evaluated; for example, $p = P - P_0$, where p is the perturbation, P is the total roll rate and $P_0$ is the reference value. The reference values are updated at the end of each integration increment as part of the quasilinearization process.

(d) The remaining calculations are performed to minimize the number of calls to the trigonometric functions used throughout the remainder of the subroutine.

"Altitude"

Due to the standard axis convention, altitude is "minus z".

"Airplane With-Respect-To Ship, Earth Axis"

Both the ship and the airplane are referenced to a fixed earth axis system. These equations calculate the x, y, and z components distance between the aircraft c.g. and the ship c.g. in that earth axis system.

"Airplane With-Respect-To Ship, Ship Wind Axis"

The airwake model requires the coordinates of the airplane relative to the ship to be in ship wind axes. These equations transform the earth axis distances to ship wind axes. The parameters DXM145, etc. were calculated in subroutine SETUP.

"Euler Angles for Airwake Model"

These are Euler angles of the airplane with respect to the ship wind axes and are necessary inputs to the airwake model equations. They are simplified greatly because the airwake model used does not pitch and roll with the ship.

"Ship Airwake"

If ship airwake is desired (NOAW = 0) subroutine AIRWAKE is called. Following the call to AIRWAKE, the airwake related parameters are available in COMMON.

"Airplane Body Axis Components of Ambient Wind"

These equations transform the ambient wind velocity, which is given in earth axes, to the aircraft body axes. Wind velocities are defined consistent with the earth axis reference, i.e. a positive x-axis wind is oriented in the positive earth axis direction.

AD-A066 173    VOUGHT CORP DALLAS TEX    F/G 1/2
VOLAR: A DIGITAL COMPUTER PROGRAM FOR SIMULATING VSTOL AIRCRAFT--ETC(U)
DEC 78 J WOLKOVITCH, B B BRASSELL    N62269-77-R-0389
UNCLASSIFIED    2-32000/8R-51672-VOL-2    NADC-77123-30-VOL-2    NL

2 OF 4
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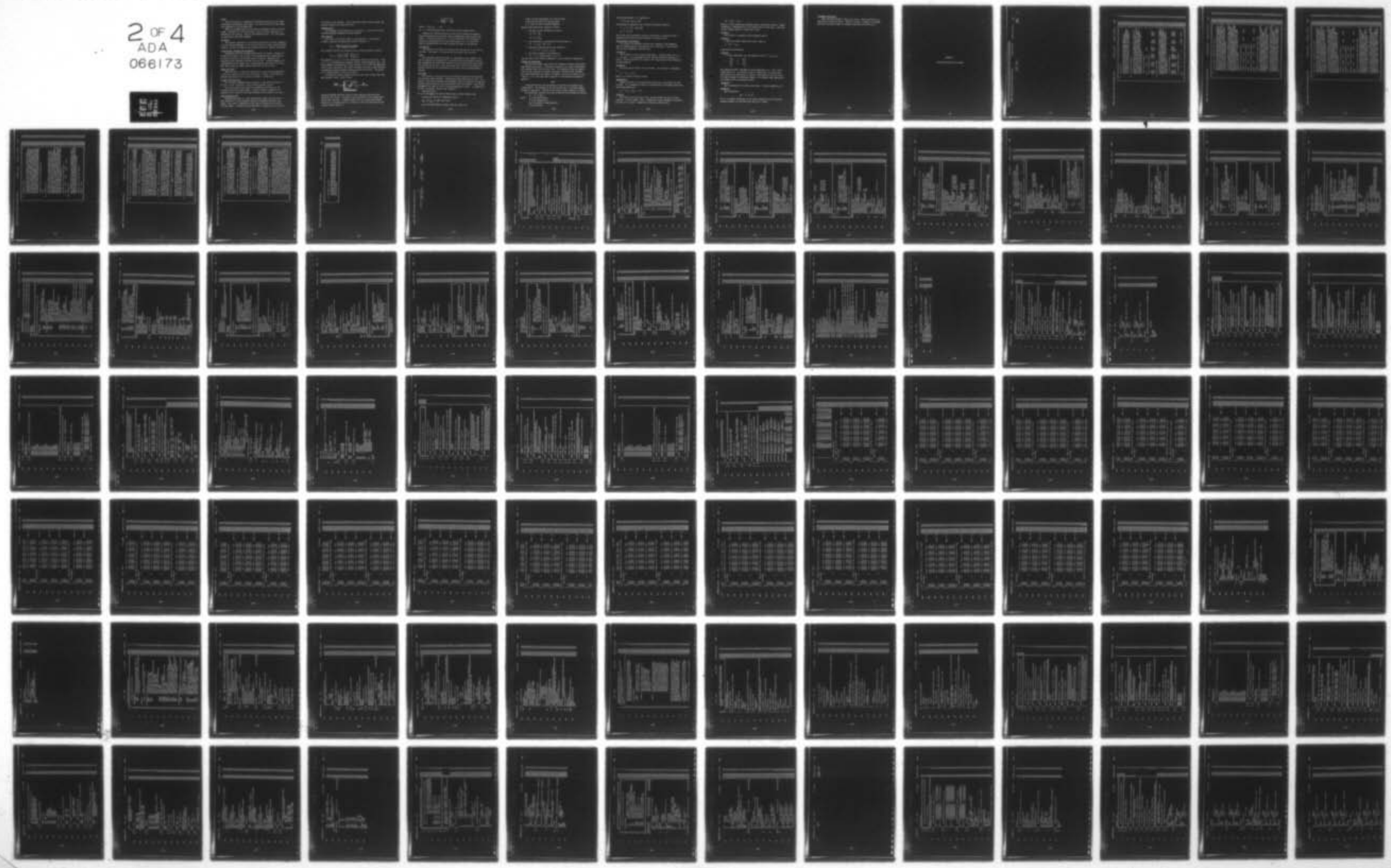
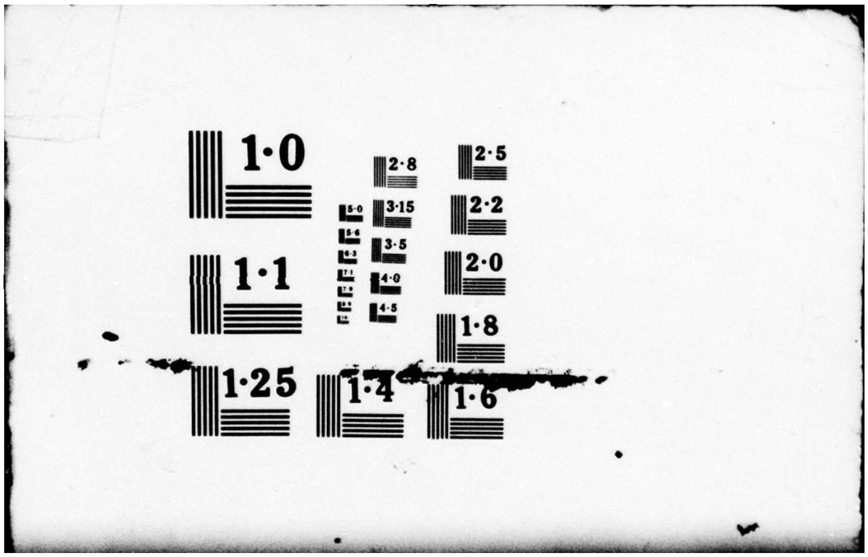



1·0
2·8
2·5
5·0
3·15
2·2
5·6
3·5
2·0
1·1
4·0
4·5
1·8
1·25
1·4
1·6

"Wind"

Total wind velocity is composed of the ambient wind and the non-random disturbances introduced by the airwake. This section defines the non-random wind components in aircraft body axes.

VOLAR is currently set-up to initialize on airspeeds instead of inertial speeds. Equations for initializing total inertial velocity components are contained in this section. They are calculated once only. This calculation is controlled by the ICEES parameter.

"Airspeed"

Wind velocity components are subtracted from inertial velocity components to yield airspeed components in the aircraft body axis system. Angle-of-attack, sideslip, and total airspeed are calculated according to standard conventions.

"Look Up Aero. and Open Loop Parameters"

Aerodynamic stability and control derivatives are stored in tables as a function of airspeed. This section of the program performs a table-look-up of these derivatives at the current value of airspeed. Subroutine TLU evaluates several dependent variables with one call. Fifteen parameters, YV through NDR (R array, segment 10), are determined by the single call to TLU. Open loop aileron and rudder control deflections are set to zero.

"Range From Ship"

Range from ship is arbitrarily defined here as the distance between the x earth axis positions of the ship and airplane. "Range", as defined here, provides some measure of how close the airplane is to the ship.

"Lateral Position Error"

The aircraft's commanded lateral position is the lateral position of the ship. Error in position is the difference between the two.

This section begins the build-up of parameters associated with the calculation of pilot control inputs. Figure 8 (Volume I, page 40) is a schematic of the classical pilot model employed for the AV-8A at low speed.

"Roll Attitude Error"

Commanded bank angle is a gain multiplied by lateral position error. Bank angle error is the difference between the commanded and actual bank angles. This error is modified by a bias term to account for the initial trim bank angle. A non-zero initial bank angle is necessary to trim out the side forces on the airplane. These side forces result from the steady side velocity required for tracking the ship.

"Heading Error"

The commanded aircraft heading is zero degrees. Heading error is the difference between commanded and actual heading.

"Roll Control"

The pilot's roll control input is calculated here. From Figure 8 (Volume I, page 40) the appropriate transfer function is:

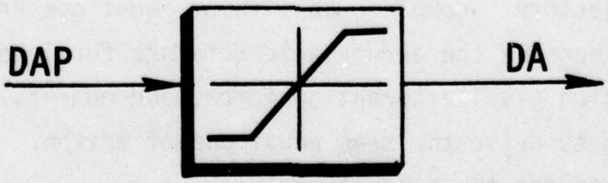
$$Y_{P_\phi} = \frac{-112.0\ (s + 0.1)\ (s - 10.0)}{(s + 10.0)\ (s + 10.0)}$$

This transfer function was obtained from the following transfer function.

$$Y_{P_\phi} = K_1\ \frac{(\tau_{L1}\ s + 1.0)}{(\tau_a\ s + 1.0)}\ \frac{(2/\tau_d - s)}{(2/\tau_d + s)}$$

The quantity $K_1\ (\tau_{L1}\ s + 1)$ is the compensation applied by the pilot. A lag, $(\tau_a\ s + 1)$, is introduced to represent actuator and neuromuscular lags. The final numerator and denominator factors provide a first order Padé approximation to a pure time delay. This delay represents the time it takes the pilot to generate an output strategy following sensing of the error. Time delays are a standard feature in most pilot models.

As presented in block diagram form below, the pilots' output, DAP, must pass through a control system limiter.



Subroutine DESCRIB calculates the non-linear describing function which represents the limiter. A necessary input to DESCRIB is the standard deviation of the signal DAP. A general equation for calculating the standard deviation of a parameter which is a function of the state variables but not a state variable itself is:

$$y = \sqrt{\left(\frac{\partial y}{\partial \underline{x}}\right)^T P \left(\frac{\partial y}{\partial \underline{x}}\right)}$$

where $y = f(x_1, x_2, \ldots, x_n)$

and $P$ is the Covariance matrix associated with the state vector $\underline{x}$.

Normally the standard deviation of the control would be evaluated by describing functions and the mean would be determined by applying the true limiter. This was not done here. For this application, the difference in results was insignificant and so the modified mean (i.e. its describing function representation) was used to reduce the number of calculations.

"Yaw Control"

This section is so similar in layout to the previous one it will not be discussed. The output is, of course, the yaw control from the pilot.

"Ship"

Only the mean lateral ship motion is considered for this example. The ship is steaming with velocity V5 in a direction PSI5 with respect to north. When integrated, the differential equation in this section yeilds the y earth-axis position of the ship. The x and z earth-axis positions were defined in previous sections of this subroutine; one by table look-up and the other by equation.

"Airframe"

This section of coding defines the differential equations which describe the aircraft's mean trajectory. Complete non-linear equations are used. This creates a small problem because the aerodynamic data are furnished as dimensional stability derivatives which give perturbation forces and moments. Total forces and moments are required to drive the mean equations of motion. To demonstrate how this is overcome, consider the $\dot{V}$ equation.

Some definitions:

Let $Y_o$ be the total side force divided by mass at some reference time.

$\delta_A$ and $\delta_R$ are the pilot commanded positions

$\delta_{A_{OL}}$ and $\delta_{R_{OL}}$ are open loop inputs

$v_{as}$ is the perturbation airspeed along the y body axis p and r are the perturbation roll and yaw rates.

P and R are the total roll and yaw rates

U, V, and W are total airspeed components

Based on these definitions proceed as follows:

1. the total control deflection is given as:

$$\delta_4 = \delta_A + \delta_{A_{OL}}$$

$$\delta_5 = \delta_R + \delta_{R_{OL}}$$

2. the incremental or perturbation force-over-mass is:

$$\Delta Y = Y_v v_{as} + Y_p p + Y_r r$$

3. the total force-over-mass on the airplane is:

$$Y = Y_o + \Delta Y + Y_{\delta_A} \delta_4 + Y_{\delta_R} \delta_5$$

4. the rate of change of side velocity is:

$$\dot{V} = Y + g \cos(\Theta) \sin(\phi) - R\,U + P\,W$$

Thus the total y-axis velocity component, V, can be found by integrating $\dot{V}$.

## "Update Sub Zero Values"

The zero subscripted values define the reference trajectory about which quasilinearisation occurs. Perturbation quantities are found by subtracting the reference value from the total value. The reference values are updated prior to each integration increment and remain fixed during the increment. Zero subscripted terms also appear as elements, or parts of elements, in the F matrix. (F is the system matrix appearing in the covariance propagation equation.)

## PROP

Subroutine PROP has only one purpose; to furnish the integration subroutine with $\dot{P}$. The prospective user should keep this in mind when reading through the subroutine. Familiarity with state variable notation is helpful.

As an overview, consider the system governed by the differential equation.

$$\dot{\underline{z}} = F\,\underline{z} + G_M\,\underline{w}$$

where $\underline{z}$ is the state vector,

F is the system matrix

$G_M$ is a control or coupling matrix

$\underline{w}$ is white noise

The covariance matrix, P, is defined by:

$$P \overset{\Delta}{=} E\{(\underline{z} - \overline{\underline{z}})(\underline{z} - \overline{\underline{z}})^T\}$$

and obtained by integrating the following differential equation.

$$\dot{P} = F P + PF^T + G_M Q_M G_M^T$$

$$Q_m \overset{\Delta}{=} E\{\underline{w}\,\underline{w}^T\}$$

Each of the titles preceding a group of calculations in subroutine PROP is explained below, with the titles repeated in quotation marks.

"Miscellaneous Calculations"

This group of calculations provides some frequently used parameters. They are grouped here for "one time per call" calculation. This minimizes calls to the trigonometric functions, etc.

"F1 Matrix"

The F1 matrix is the aircraft system matrix. Aircraft states are v, p, r, $\phi$, $\psi$, and y. F1 is developed from the standard linearized equations of motion. Refer to Section 2.0 in Volume I for a description of the linearized aircraft equations.

"G1 Matrix"

G1 is the control matrix for the airplane. The airplane is represented by:

$$\dot{\underline{x}} = F_1 \underline{x} + G_1 \underline{u}$$

where $\underline{u}$ is a vector of control inputs.

"Gamma Matrix"

Gamma is the matrix for coupling the colored noise disturbances with the airplane. If $\underline{w}'$ represents a vector of colored noises, the equations describing the airplane motion are.

$$\dot{\underline{x}} = F_1 \underline{x} + G_1 \underline{u} + \Gamma \underline{w}'$$

"A Matrix"

The A matrix and the B matrix (next section) define the noise coloring processes. In this example, noise is composed of Dryden atmospheric turbulence, plus the ship's airwake. Equations for the noise take the form:

$$\dot{\underline{w}}' = A\,\underline{w}' + B\,\underline{w}$$

where $\underline{w}'$ is the colored noise (output) and $\underline{w}$ is white noise (input). Dryden turbulence is represented by a first order filter (in each axis). Each axis of ship airwake requires a second order filter.

"B Matrix"

The B matrix is explaned in the preceeding section.

"C Matrix"

C and $R_L$ are used to define the control input, $\underline{u}$.

$$\dot{\underline{u}} = C\underline{x} + R_L\,\underline{u}$$

$\underline{x}$ and $\underline{u}$ are explained above.

"F Matrix"

F is the system matrix for the augmented vector $\underline{z}^T = (\underline{x}, \underline{w}', \underline{u})$:

$$F = \begin{bmatrix} F_1 & \Gamma & G_1 \\ 0 & A & 0 \\ C & 0 & R_L \end{bmatrix}$$

The subroutine LAYIN is designed to store submatrices ($F_1$, $\Gamma$, etc.) into a larger matrix (F). By building F from its submatrices; (1) the user has more visibility of the pieces, (2) there is less chance of an error in row or column placement of individual elements, (3) elemental model additions or size changes can be incorporated quickly.

"GM Matrix"

$G_M$ is the multiplier of white noise inputs. For this example $G_M \equiv B$.

"QM Matrix"

$Q_M$ is defined by:

$$Q_M = E\ \{\underline{w}\ \underline{w}^T\}$$

The (1, 1) element corresponds to the Dryden turbulence and the remaining diagonal elements are associated with the ship's airwake.

"Propagate Covariances"

These operations develop $\dot{P}$ from F, $G_M$, and $Q_M$. Matrix operations are identified in subroutine MATRIX. MATRIX is written in COMPASS; but FORTRAN equivalent subroutines appear as comments preceeding each ENTRY point.

# APPENDIX B

# LISTING FOR CLASSICAL PILOT MODEL

```
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

       VOUGHT LAUNCH AND RECOVERY PROGRAMMING NOTES.               COMPASS 3.3-428.     12/06/78  15.13.15.      PAGE      1

                                      IDENT  NOTES                                                            NOTES       2
                                      LIST   -B,-R,-N                                                         NOTES       4
```

```
********************************************************************** NOTES
*                                                                    * NOTES
*   I.   INTRODUCTION                                                * NOTES
*                                                                    * NOTES
*        THE VOLAR (VOUGHT LAUNCH AND RECOVERY) PROGRAM WAS          * NOTES
*        DEVELOPPED BY VOUGHT CORPORATION UNDER CONTRACT NUMBER      * NOTES
*        N62269-77-C-0389 11 OCT 77. THE PURPOSE OF THIS DISCUSSION  * NOTES
*        IS TO PROVIDE THE PROGRAMMER (OR USER) WITH DOCUMENTATION   * NOTES
*        TO BE USED AS AN AID IN MODIFING THE EXISTING PROGRAM.      * NOTES
*                                                                    * NOTES
*   II.  ROUTINE CLASSIFICATION                                      * NOTES
*                                                                    * NOTES
*        ALL ROUTINES INCLUDED IN THIS PROGRAM MAY BE CLASSIFIED AS  * NOTES
*        MEMBERS IN ONE OF TWO MAJOR CLASSIFICATIONS. CLASS I        * NOTES
*        ROUTINES INCLUDE THOSE ROUTINES WHOSE OPERATION IS DEPENDENT * NOTES
*        UPON EQUATIONS DERIVED FOR THE SPECIFIC PROBLEM AT HAND.    * NOTES
*        CLASS II ROUTINES INCLUDE THOSE ROUTINES WHOSE OPERATION IS * NOTES
*        INDEPENDENT OF THE SPECIFIC PROBLEM WITH THE POSSIBLE       * NOTES
*        EXCEPTION OF ARRAY DIMENSIONS.                              * NOTES
*                                                                    * NOTES
*        CLASS I ROUTINES INCLUDE :                                  * NOTES
*                                                                    * NOTES
*        DEQU      MISCAL    PROP      SETUP                         * NOTES
*                                                                    * NOTES
*        CLASS II ROUTINES INCLUDE :                                 * NOTES
*                                                                    * NOTES
*        VOLAR     ADAMS     AIRWAKE   AIRWTBL   AXIS      CALPLT    * NOTES
*        DASPLT    DESCRIB   ELLIPSE   KUTTA     MATINV    MATRIX    * NOTES
*        PRNPLT    ROTATE    RUNGE     SOLVR     TABRD     TLU       * NOTES
*                                                                    * NOTES
*   III. SOURCE CODE FORMAT                                          * NOTES
*                                                                    * NOTES
*        DUE TO THE NATURE OF THE PROBLEM (I.F. CHANGES IN PROBLEM   * NOTES
*        SPECIFICATIONS REQUIRE CHANGES IN SOURCE CODE), THE ORIGINAL * NOTES
*        SOURCE CODE WAS DEVELOPPED AND DELIVERED IN CDC *UPDATE*    * NOTES
*        FORMAT AND WE STRONGLY RECOMMEND MAINTAINING THE PROGRAM IN * NOTES
*        THAT FORMAT. ALL ROUTINES DELIVERED WERE MAINTAINED AS      * NOTES
*        SEPERATE *DECK*S AND ALL COMMON AREAS WERE MAINTAINED AS    * NOTES
*        SEPERATE *COMDECK*S.                                        * NOTES
*                                                                    * NOTES
*        THE *DECK* NAMES INCLUDE :                                  * NOTES
*                                                                    * NOTES
*        VOLAR     ADAMS     AIRWAKE   AIRWTBL   AXIS      CALPLT    * NOTES
*        DASPLT    DEQU      DESCRIB   ELLIPSE   KUTTA     MATINV    * NOTES
*        MATRIX    MISCAL    PRNPLT    PROP      RUNGE     ROTATE    * NOTES
*        SETUP     SOLVR     TABRD     TLU                           * NOTES
*                                                                    * NOTES
*        THE *COMDECK* NAMES INCLUDE :                               * NOTES
*                                                                    * NOTES
*        R         R2        I         I2        SEGMENT   INTEG     * NOTES
*        GDF                                                         * NOTES
*                                                                    * NOTES
********************************************************************** NOTES
```

```
****************************************************************************** NOTES
*                                                                            * NOTES
*     IV.  I AND R ARRAYS - *COMDECK*S I, I2, R AND R2                       * NOTES
*                                                                            * NOTES
*          PROBLEM-SPECIFIC INTEGER AND REAL VARIABLES ARE COLLECTED         * NOTES
*          INTO THE I AND R ARRAYS RESPECTIVELY. RELATED VARIABLES ARE       * NOTES
*          GROUPPED TOGETHER INTO I OR R ARRAY SEGMENTS. AT PROBLEM          * NOTES
*          INITIATION, THE USER INPUTS THE NUMBER OF SEGMENTS AND THE        * NOTES
*          LENGTH OF EACH SEGMENT CONTAINED IN THE I AND R ARRAYS. INPUT* NOTES
*          TO OR OUTPUT FROM A SPECIFIC VARIABLE IS ACCOMPLISHED BY          * NOTES
*          SPECIFING THE SEGMENT NUMBER AND RELATIVE LOCATION WITHIN         * NOTES
*          THE SEGMENT WHERE THE VARIABLE RESIDES.                           * NOTES
*                                                                            * NOTES
*          THE R ARRAY IS LOCATED IN *COMDECK*S R AND R2, THE I ARRAY IN* NOTES
*          I AND I2. *COMDECK*S I AND R ARE CALLED FROM ROUTINES WHICH       * NOTES
*          REQUIRE SPECIFIC VARIABLES FROM THE ARRAYS. *COMDECK*S R2         * NOTES
*          AND I2 ARE CALLED FROM ROUTINES WHICH CAN OPERATE USING I         * NOTES
*          AND R AS LARGE SINGLE-DIMENSIONED ARRAYS. THE LONE EXCEPTION * NOTES
*          OCCURS IN ROUTINE SETUP WHERE BOTH FORMS OF THE R ARRAY ARE       * NOTES
*          USED. IN THIS CASE *COMDECK* R IS CALLED AND THE FIRST            * NOTES
*          LOCATION OF A LOCAL ARRAY IS EQUIVALENCED TO THE FIRST            * NOTES
*          VARIABLE IN THE R ARRAY.                                          * NOTES
*                                                                            * NOTES
*          *COMDECK* R IS CALLED FROM *DECK*S :                              * NOTES
*                                                                            * NOTES
*          AIRWAKE    AIRWTBL    DEQU       MISCAL     PROP       SETUP      * NOTES
*                                                                            * NOTES
*          *COMDECK* R2 IS CALLED FROM *DECK*S :                             * NOTES
*                                                                            * NOTES
*          ADAMS      COVAR      KUTTA      RUNGE                            * NOTES
*                                                                            * NOTES
*          *COMDECK* I IS CALLED FROM *DECK*S :                              * NOTES
*                                                                            * NOTES
*          ADAMS      DEQU       KUTTA      MISCAL     PROP       RUNGE      * NOTES
*          SETUP                                                             * NOTES
*                                                                            * NOTES
*          *COMDECK* I2 IS CALLED ONLY FROM *DECK* VOLAR.                    * NOTES
*                                                                            * NOTES
*          NEARLY ALL ROUTINES WHICH OPERATE USING *COMDECK* R2 REQUIRE * NOTES
*          SPECIFIC INTEGRATION CONTROL VARIABLES WHICH ARE LOCATED          * NOTES
*          WITHIN THE R ARRAY. THEREFORE, *COMDECK* R2 CONTAINS              * NOTES
*          EQUIVALENCE STATEMENTS WHICH EQUIVALENCE THE CONTROL              * NOTES
*          VARIABLES WITH THEIR ASSOCIATED LOCATIONS IN THE R ARRAY.         * NOTES
*          A CHANGE IN LOCATION OF THE CONTROL VARIABLES WOULD REQUIRE       * NOTES
*          A CHANGE IN THE ASSOCIATED EQUIVALENCE STATEMENT.                 * NOTES
*                                                                            * NOTES
*          SINCE THE R ARRAY IS LOCATED IN BLANK COMMON WHICH, AT LOAD       * NOTES
*          TIME, IS ASSIGNED THE LARGEST LENGTH FOUND ON THE LOAD FILES,* NOTES
*          CHANGING THE CONTENTS OF *COMDECK* R NEED NOT INVOLVE A           * NOTES
*          CHANGE TO *COMDECK* R2 UNLESS THE CHANGE MODIFIES THE             * NOTES
*          LOCATION OF AN INTEGRATION CONTROL VARIABLE. THE I ARRAY IS       * NOTES
*          LOCATED IN A LABELLED COMMON BLOCK, /INTEGER/. THEREFORE A        * NOTES
*          CHANGE IN *COMDECK* I SHOULD ALSO BE REFLECTED IN *COMDECK*       * NOTES
*          I2.                                                               * NOTES
*                                                                            * NOTES
****************************************************************************** NOTES
```

```
*********************************************************************** NOTES        60
*                                                                     * NOTES        61
*     IV.  I AND R ARRAYS - *COMDECK*S I, I2, R AND R2                * NOTES        62
*                                                                     * NOTES        63
*          PROBLEM-SPECIFIC INTEGER AND REAL VARIABLES ARE COLLECTED  * NOTES        64
*          INTO THE I AND R ARRAYS RESPECTIVELY. RELATED VARIABLES ARE * NOTES       65
*          GROUPPED TOGETHER INTO I OR R ARRAY SEGMENTS. AT PROBLEM   * NOTES        66
*          INITIATION, THE USER INPUTS THE NUMBER OF SEGMENTS AND THE * NOTES        67
*          LENGTH OF EACH SEGMENT CONTAINED IN THE I AND R ARRAYS. INPUT* NOTES      68
*          TO OR OUTPUT FROM A SPECIFIC VARIABLE IS ACCOMPLISHED BY   * NOTES        69
*          SPECIFING THE SEGMENT NUMBER AND RELATIVE LOCATION WITHIN  * NOTES        70
*          THE SEGMENT WHERE THE VARIABLE RESIDES.                    * NOTES        71
*                                                                     * NOTES        72
*          THE R ARRAY IS LOCATED IN *COMDECK*S R AND R2, THE I ARRAY IN* NOTES      73
*          I AND I2. *COMDECK*S I AND R ARE CALLED FROM ROUTINES WHICH * NOTES       74
*          REQUIRE SPECIFIC VARIABLES FROM THE ARRAYS. *COMDECK*S R2  * NOTES        75
*          AND I2 ARE CALLED FROM ROUTINES WHICH CAN OPERATE USING I  * NOTES        76
*          AND R AS LARGE SINGLE-DIMENSIONED ARRAYS. THE LONE EXCEPTION * NOTES      77
*          OCCURS IN ROUTINE SETUP WHERE BOTH FORMS OF THE R ARRAY ARE * NOTES       78
*          USED. IN THIS CASE *COMDECK* R IS CALLED AND THE FIRST     * NOTES        79
*          LOCATION OF A LOCAL ARRAY IS EQUIVALENCED TO THE FIRST     * NOTES        80
*          VARIABLE IN THE R ARRAY.                                   * NOTES        81
*                                                                     * NOTES        82
*          *COMDECK* R IS CALLED FROM *DECK*S :                       * NOTES        83
*                                                                     * NOTES        84
*          AIRWAKE    AIRWTBL    DEQU       MISCAL     PROP       SETUP * NOTES      85
*                                                                     * NOTES        86
*          *COMDECK* R2 IS CALLED FROM *DECK*S :                      * NOTES        87
*                                                                     * NOTES        88
*          ADAMS      COVAR      KUTTA      RUNGE                     * NOTES        89
*                                                                     * NOTES        90
*          *COMDECK* I IS CALLED FROM *DECK*S :                       * NOTES        91
*                                                                     * NOTES        92
*          ADAMS      DEQU       KUTTA      MISCAL     PROP       RUNGE * NOTES      93
*          SETUP                                                      * NOTES        94
*                                                                     * NOTES        95
*          *COMDECK* I2 IS CALLED ONLY FROM *DECK* VOLAR.             * NOTES        96
*                                                                     * NOTES        97
*          NEARLY ALL ROUTINES WHICH OPERATE USING *COMDECK* R2 REQUIRE * NOTES      98
*          SPECIFIC INTEGRATION CONTROL VARIABLES WHICH ARE LOCATED   * NOTES        99
*          WITHIN THE R ARRAY. THEREFORE, *COMDECK* R2 CONTAINS       * NOTES       100
*          EQUIVALENCE STATEMENTS WHICH EQUIVALENCE THE CONTROL       * NOTES       101
*          VARIABLES WITH THEIR ASSOCIATED LOCATIONS IN THE R ARRAY.  * NOTES       102
*          A CHANGE IN LOCATION OF THE CONTROL VARIABLES WOULD REQUIRE * NOTES      103
*          A CHANGE IN THE ASSOCIATED EQUIVALENCE STATEMENT.          * NOTES       104
*                                                                     * NOTES       105
*          SINCE THE R ARRAY IS LOCATED IN BLANK COMMON WHICH, AT LOAD * NOTES      106
*          TIME, IS ASSIGNED THE LARGEST LENGTH FOUND ON THE LOAD FILES,* NOTES     107
*          CHANGING THE CONTENTS OF *COMDECK* R NEED NOT INVOLVE A    * NOTES       108
*          CHANGE TO *COMDECK* R2 UNLESS THE CHANGE MODIFIES THE      * NOTES       109
*          LOCATION OF AN INTEGRATION CONTROL VARIABLE. THE I ARRAY IS * NOTES      110
*          LOCATED IN A LABELLED COMMON BLOCK, /INTEGER/. THEREFORE A * NOTES       111
*          CHANGE IN *COMDECK* I SHOULD ALSO BE REFLECTED IN *COMDECK* * NOTES      112
*          I2.                                                        * NOTES       113
*                                                                     * NOTES       114
*********************************************************************** NOTES       115
```

```
******************************************************************************** NOTES      117
*                                                                              * NOTES      118
*    V.    *COMDFCK* SFGMENT                                                   * NOTES      119
*                                                                              * NOTES      120
*          THE INITIAL INPUT TO THE PROGRAM IS A NAMELIST, SFGMNT,             * NOTES      121
*          WHICH DEFINES THE NUMBER OF SEGMENTS AND THE LENGTH OF EACH         * NOTES      122
*          SEGMENT CONTAINED IN THE I AND R ARRAYS. THIS INFORMATION           * NOTES      123
*          IS STORFD IN A LABFLLED COMMON BLOCK, /SEGMFNT/, CONTAINED          * NOTES      124
*          IN *CCMDECK* SFGMENT. ADDINC OR DELFTING VARIABLES FROM AN          * NOTES      125
*          FXISTING SEGMFNT REQUIRES A CHANGE TO THE ASSOCIATED INPUT          * NOTES      126
*          FCR THAT SEGMENT. ADDING SEGMENTS TO THE TAIL END OF THE I          * NOTES      127
*          OR R ARRAY RECUIRES AN ADDITIONAL INPUT FOR EACH ADDITIONAL         * NOTES      128
*          SEGMENT AND A POSSIBLE INCREASE IN THE ARRAY DIMENSION FOR          * NOTES      129
*          THE ASSOCIATED I OR R ARRAY DFSCRIPTOR IN *CCMDECK* SEGMENT.        * NOTES      130
*                                                                              * NOTES      131
*          *COMDECK* SEGMENT IS CALLED FROM *DECK*S :                          * NOTES      132
*                                                                              * NOTES      133
*          VOLAR                                                               * NOTES      134
*                                                                              * NOTES      135
*    VI.   *CCMDECK* INTFG                                                     * NCTES      136
*                                                                              * NOTES      137
*          THIS *CUMDECK* CUNTAINS A LABELLED COMMON BLOCK, /INTEG/,           * NOTES      138
*          WHICH IS USED TO HOLD TWO SINGLE-DIMENSIONED ARRAYS OF              * NOTES      139
*          LENGTH NEOU WHERE NEOL IS THE SUM CF THE NUMBER OF STATE            * NOTES      140
*          VARIABLES AND THE SQUARE OF THE NUMBER OF ROWS IN THE               * NOTES      141
*          COVARIANCE MATRIX. THESE ARRAYS ARE USED TO HOLD TEMPORARY          * NOTES      142
*          INTEGRATION VALUES. IT SHOULD BE NOTED THAT THESE ARRAYS ARE        * NOTES      143
*          ALSC USED AS SCRATCH MATRICIES IN ROUTINE SOLVR WHICH               * NOTES      144
*          PREVENTS SOLVR FROM BEING CALLED FROM WITHIN THE INTEGRATION        * NOTES      145
*          LOOP (SEE SCLVR NOTFS). AN INCREASE IN THE NUMBFR OF STATE          * NOTES      146
*          VARIABLES OR NUMBER OF ROWS IN THE COVARIANCE MATRIX REQUIRE        * NOTES      147
*          A CHANGE IN THE ARRAY DIMENSIONS.                                   * NOTES      148
*                                                                              * NOTES      149
*          *COMDECK* INTEG IS CALLED FROM *DECK*S :                            * NOTES      150
*                                                                              * NOTES      151
*          ADAMS      KUTTA      PROP      RUNGE      SETUP                    * NOTES      152
*                                                                              * NOTES      153
*    VII.  *COMDECK* GDF                                                       * NOTES      154
*                                                                              * NOTES      155
*          THIS *COMDECK* CONTAINS THE LABELLED COMMON BLOCK, /GDF/,           * NOTES      156
*          WHICH IS USED TO HOLD THE NUMBFR OF DESCRIBING FUNCTION, THE        * NOTES      157
*          FUNCTIONS THEMSELVES AND INDEXES FOR THE FUNCTIONS.  IF THE         * NOTES      158
*          NUMBER OF DESCRIBING FUNCTION INCREASE, THE DIMENSION ON THE        * NOTES      159
*          FUNCTION VALUES (TABLE) MAY NEED TO BE INCREASED.                   * NOTES      160
*                                                                              * NOTES      161
*          *COMDECK* GDF IS CALLED FROM *DECK*S :                              * NOTES      162
*                                                                              * NOTES      163
*          DESCRIB    TABRD                                                    * NOTES      164
*                                                                              * NOTES      165
******************************************************************************** NOTES      166
```

```
************************************************************************ NOTES   168
*                                                                      * NOTES   169
*   VIII. CENTRAL MEMORY REQUIREMENTS AND EXECUTION TIME               * NOTES   170
*                                                                      * NOTES   171
*         SEVERAL STEPS WERE TAKEN TO REDUCE EXECUTION TIME AND CENTRAL* NOTES   172
*         MEMORY REQUIREMENTS. THE FOLLOWING DISCUSSION IS DESIGNED TO * NOTES   173
*         POINT OUT WHERE THOSE STEPS WERE TAKEN AND THE STEPS REQUIRED* NOTES   174
*         TO RELAX THE CONSTRAINTS THEY IMPOSE.                        * NOTES   175
*                                                                      * NOTES   176
*      A. AIRWAKE MODEL - *DECK*S AIRWAKE AND AIRWTBL                  * NOTES   177
*                                                                      * NOTES   178
*         THE AIRWAKE MODEL PERFORMS A SERIES OF TABLE LOOKUPS TO      * NOTES   179
*         OBTAIN VX, VY, VZ, SIGMA VX, SIGMA VY AND SIGMA VZ BASED UPON* NOTES   180
*         THE RELATIVE LOCATION OF THE AIRPLANE TO THE SHIP. EACH TABLE* NOTES   181
*         CONTAINS SEVENTY-FIVE ENTRIES AND IS PLACED INTO THE R ARRAY * NOTES   182
*         IN THE ABOVE MENTIONED ORDER. TO REDUCE THE AMOUNT OF CODING * NOTES   183
*         NECESSARY TO PERFORM THE TABLE LOOKUPS, ALL SIX TABLES ARE   * NOTES   184
*         CONSIDERED AS ONE LARGE TABLE AND THE LOOKUP IS PERFORMED ON * NOTES   185
*         THE PROPER SECTION OF THE LARGER TABLE. THIS REQUIRES THE    * NOTES   186
*         TABLES BE PLACED IN CONSECUTIVE LOCATIONS OF THE R ARRAY IN  * NOTES   187
*         THE ABOVE MENTIONED ORDER. THIS CAN BE ALLIVIATED BY         * NOTES   188
*         ALTERING THE SECTION OF CODE PERFORMING THE TABLE LOOKUPS IN * NOTES   189
*         ROUTINES AIRWAKE AND AIRWTBL.                                * NOTES   190
*                                                                      * NOTES   191
*      B. INTEGRATORS - *DECK*S RUNGE, KUTTA AND ADAMS                 * NOTES   192
*                                                                      * NOTES   193
*         THE USER MUST INPUT THE LOCATIONS WITHIN THE R ARRAY OF THE  * NOTES   194
*         STATE VARIABLES, THE COVARIANCE MATRIX AND THEIR DERIVATIVES.* NOTES   195
*         THESE LOCATIONS ARE THEN STORED INTO THE I ARRAY TO BE USED  * NOTES   196
*         BY THE INTEGRATORS. TO REDUCE THE AMOUNT OF STORAGE REQUIRED * NOTES   197
*         BY THE I ARRAY, ONLY THE FIRST ELEMENT LOCATIONS OF THE      * NOTES   198
*         COVARIANCE MATRIX AND THE DERIVATIVE MATRIX ARE STORED INTO  * NOTES   199
*         THE I ARRAY ALONG WITH THE NUMBER OF ELEMENTS IN EACH MATRIX.* NOTES   200
*                                                                      * NOTES   201
*      C. CALCOMP PLOTTER - *DECK*S CALPLT, AXIS, DASPLT, ELLIPSE AND  * NOTES   202
*                                         ROTATE                       * NOTES   203
*                                                                      * NOTES   204
*         THE ABOVE MENTIONED *DECK*S ARE USED TO PRODUCE PLOTS ON AN  * NOTES   205
*         INCREMENTAL PEN PLOTTER (CALCOMP) AND ARE DEPENDENT UPON THE * NOTES   206
*         AVAILABILITY OF THE ASSOCIATED CALCOMP SOFTWARE. SHOULD THE  * NOTES   207
*         SOFTWARE NOT BE AVAILABLE, THE ROUTINES AND THE ASSOCIATED   * NOTES   208
*         INPUT OPTIONS IN VOLAR WHICH INVOKE THESE ROUTINES SHOULD BE * NOTES   209
*         DELETED FROM THE PROGRAM.                                    * NOTES   210
*                                                                      * NOTES   211
*      D. PRINTER PLOTTER - *DECK* PRNPLT                              * NOTES   212
*                                                                      * NOTES   213
*         THIS ROUTINE IS USED TO PRODUCE A 7 BY 7 INCH PLOT ON A      * NOTES   214
*         36 ROW, 61 COLUMN SECTION OF A PRINTED PAGE. THE PLOT IS     * NOTES   215
*         PLACED INTO AN ARRAY AND TO SAVE SPACE THE 61 COLUMNS ARE    * NOTES   216
*         COMPRESSED INTO 7 60-BIT WORDS. THIS CAN BE REPLACED BY      * NOTES   217
*         STORING THE PLOT INTO A 61 BY 36 ARRAY RATHER THAN A 7 BY 36 * NOTES   218
*         ARRAY.                                                       * NOTES   219
*                                                                      * NOTES   220
************************************************************************ NOTES   221
```

```
*************************************************************************** NOTES     223
*                                                                         * NOTES     224
*     E. INTEGRATION INITIATION - *DECK* SETUP                            * NOTES     225
*                                                                         * NOTES     226
*        THIS ROUTINE IS CALLED PRIOR TO INITIATING THE INTEGRATION       * NOTES     227
*        LOOP. IT IS USED TO HACK THE INITIAL VALUES USED BY THE          * NOTES     228
*        INTEGRATORS. IT IS ALSO USED TO HACK NON-TIME VARING NUMBERS.* NOTES     229
*        AS AN EXAMPLE, THE AIRWAKE MODEL REQUIRES THE WIND-OVER-DECK     * NOTES     230
*        AND SHIP HEADING WHICH, ONCE SET, NEVER VARY. TO KEEP THESE      * NOTES     231
*        HACKS OUT OF THE INTEGRATION LOOP, THEY ARE PERFORMED IN         * NOTES     232
*        SETUP.                                                           * NOTES     233
*                                                                         * NOTES     234
*     F. TABLE LOOKUP ROUTINE - *DECK* TLU                                * NOTES     235
*                                                                         * NOTES     236
*        THIS ROUTINE IS USED TO LOOK UP A SERIES OF VALUES BASED UPON* NOTES     237
*        A SERIES OF TABLES AND A SINGLE INDEPENDENT VARIABLE. THIS       * NOTES     238
*        REQUIRES THAT ALL DEPENDENT VARIABLE TABLES TO BE LOOKED UP      * NOTES     239
*        BY A SINGLE CALL MUST HAVE THE SAME NUMBER OF ITEMS IN THE       * NOTES     240
*        TABLE AND BE LOCATED IN CONSECUTIVE AREAS OF CORE. THE           * NOTES     241
*        DEPENDENT VARIABLE VALUES WILL BE PLACED IN A CONTIGUOUS         * NOTES     242
*        AREA OF CORE IN THE SAME ORDER AS THEIR TABLES ARE ARRANGED.     * NOTES     243
*                                                                         * NOTES     244
*     G. COVARIANCE MATRIX INITIALIZATION - *DECK* SOLVR                  * NOTES     245
*                                                                         * NOTES     246
*        THIS ROUTINE SOLVES FOR P IN THE RICCATI EQUATION                * NOTES     247
*                                                                         * NOTES     248
*        P * F TRANSPOSE + F * P + G * Q * G TRANSPOSE = 0                * NOTES     249
*                                                                         * NOTES     250
*        TO INITIALIZE THE COVARIANCE MATRIX. THE ROUTINE NEEDS 3 N       * NOTES     251
*        BY N SCRATCH MATRICIES (N = NUMBER OF ROWS IN COVARIANCE         * NOTES     252
*        MATRIX P). TO SAVE SPACE, THE COVARIANCE DERIVATIVE MATRIX       * NOTES     253
*        AND THE TWO SCRATCH INTEGRATION MATRICIES ARE USED FOR THIS      * NOTES     254
*        PURPOSE. THIS PREVENTS CALLING SOLVR INSIDE THE INTEGRATION      * NOTES     255
*        LOOP TO FIND THE STEADY-STATE P MATRIX. THIS CAN BE ACHIEVED     * NOTES     256
*        BY ADDING 3 ADDITIONAL N BY N MATRICIES TO ROUTINE PROP AND      * NOTES     257
*        PLACING THESE MATRICIES INTO THE CALL TO SOLVR.                  * NOTES     258
*                                                                         * NOTES     259
*     H. MATRIX MANIPULATION - *DECK* MATRIX                              * NOTES     260
*                                                                         * NOTES     261
*        SEVERAL MATRIX MANIPULATIONS (ADD, MULTIPLY AND TRANSPOSE)       * NOTES     262
*        OCCUR IN GENERATING THE COVARIANCE MATRIX. SINCE THE TIME        * NOTES     263
*        REQUIRED TO MULTIPLY TWO MATRICIES RISES EXPONENTIALLY WITH      * NOTES     264
*        THE SIZE OF THE MATRIX, THESE ROUTINES HAVE BEEN COLLECTED       * NOTES     265
*        INTO AN ASSEMBLY LANGUAGE ROUTINE. THIS ROUTINE IS DESIGNED      * NOTES     266
*        TO KEEP ALL LOOPING INSIDE THE INSTRUCTION STACK LOCATED         * NOTES     267
*        INSIDE THE CPU OF THE 6600, THEREBY REDUCING THE EXECUTION       * NOTES     268
*        TIME SIGNIFICANTLY. WE REALIZE THIS MAKES DEBUGGING AND          * NOTES     269
*        MODIFICATION OF THIS ROUTINE MORE DIFFICULT BUT, CONSIDERING     * NOTES     270
*        THE SIZE OF THE MATRICIES INVOLVED AND THE NUMBER OF TIMES       * NOTES     271
*        THESE ROUTINES ARE CALLED, WE FEEL IT IS ADVANTAGEOUS TO USE     * NOTES     272
*        THE ROUTINE IN ITS PRESENT FORM. THE FORTRAN EQUIVALENT OF       * NOTES     273
*        THESE ROUTINES HAVE BEEN GENERATED AND ARE AVAILABLE FOR USE     * NOTES     274
*        SHOULD THIS ROUTINE BE UNDESIRABLE.                              * NOTES     275
*************************************************************************** NOTES     276
```

```
*************************************************************************** NOTES      278
*                                                                         * NOTES      279
*                                                                         * NOTES      280
*      IX. COVARIANCE MATRICIES                                           * NOTES      281
*                                                                         * NOTES      282
*          THE MATRIX MANIPULATION ROUTINES AND INTEGRATORS ASSUME THE    * NOTES      283
*          COVARIANCE MATRICIES ARE SQUARE MATRICIES AND ARE NOT OVER-    * NOTES      284
*          DIMENSIONED. OVER-DIMENSIONING CAUSES SO MANY PROBLEMS WE      * NOTES      285
*          FEEL IT IS MANDITORY THAT THESE MATRICIES BE KEPT WITH THE     * NOTES      286
*          PROPER DIMENSIONS.                                             * NOTES      287
*                                                                         * NOTES      288
*************************************************************************** NOTES      289
```

```
VOUGHT LAUNCH AND RECOVERY PROGRAMMING NOTES.                  COMPASS 3.3-428.      12/08/78  15.13.15.       PAGE       8

      0                      END                                                                             NOTES      291

                  50000B CM  STORAGE USED            290 STATEMENTS          0 SYMBOLS
                             MODEL 74 ASSEMBLY     0.806 SECONDS             0 REFERENCES
      PROGRAM VOLAR(INPUT,OUTPUT,PUNCH,TAPE2=1002B,TAPE3=1002B,TAPE10,  VCLAR      3
     *              TAPE28=0,TAPE5=INPUT,TAPE6=OUTPUT,TAPE7=PUNCH)       VOLAR      4
C********************************************************************** VCLAR      5
C*                                                                    * VCLAR      6
C*       VOUGHT LAUNCH AND RECOVERY PROGRAM (DRIVER ROUTINE)          * VOLAR      7
C*       DEVELOPPED UNDER CONTRACT NO. N62269-77-C-0389  11 OCT 77.   * VOLAR      8
C*                                                                    * VCLAR      9
C********************************************************************** VOLAR     10
      DIMENSION FMTI(4),FMTO(4),HDG(10),IO(200),LABEL(5),LBLOUT(7),     VCLAR     11
     A          NC(10),NCOL(10),NFIL(10),NP(10),OUT(10),ROW(200),       VOLAR     12
     B          SCAL(10),TITLE(32),LABELX(4),LABELY(4),LEGEND(4)        VOLAR     13
      REAL      LNGTHX,LNGTHY                                           VCLAR     14
      INTEGER   FMTI,FMTO                                               VOLAR     15
C  *                                                                    R2         2
C  ***   REAL VARIABLES (PROBLEM DEPENDENT).                            R2         3
C  *                                                                    R2         4
      COMMON R(6)                                                       R2         5
C  *                                                                    R2         6
C  ***   INTEGRATION VARIABLES (LOCATIONS ARE PROBLEM DEPENDENT).       R2         7
C  *                                                                    R2         8
      EQUIVALENCE (TI,R(1)),(TO,R(2)),(DT,R(3)),(DTOUT,R(4)),           R2         9
     A            (DTOUT2,R(5)),(TMAX,R(6))                             R2        10
C  *                                                                    I2         2
C  ***   INTEGER VARIABLES (PROBLEM DEPENDENT).                         I2         3
C  *                                                                    I2         4
      COMMON/INTEGER/IN(44)                                             I2         5
C  *                                                                    SEGMENT    2
C  ***   SEGMENT DESCRIPTORS FOR I AND R ARRAYS (PROBLEM DEPENDENT).    SEGMENT    3
C  *                                                                    SEGMENT    4
      COMMON/SEGMENT/NSEGI,NI(25),NSEGR,NR(150)                         SEGMENT    5
C  *                                                                    VOLAR     19
C  ***   NAMELIST DEFINITIONS.                                          VOLAR     20
C  *                                                                    VCLAR     21
      NAMELIST/CURVE/ NDATA,NCOLX,NCOLY,NCX,NCY,NCXY,LINTYP,DASH,NSYM,  VCLAR     22
     A                SCALEX,SCALEY,SCALXX,SCALYY                       VCLAR     23
      NAMELIST/PLOTD/ NCURVS,ANGLE,XPLOT,YPLOT,XEXIT,YEXIT,XLEGND,      VCLAR     24
     A                YLEGND,XORG,YORG,LNGTHX,LNGTHY,STARTX,STARTY,     VCLAR     25
     B                DELX,DELY,ISOPT                                   VCLAR     26
      NAMELIST/SEGMNT/ NSEGI,NI,NSEGR,NR,NPRNT                          VCLAR     27
C********************************************************************** VCLAR     28
C*                                                                    * VCLAR     29
C*       INITIALIZE SEGMENT DESCPIPTORS FOR I AND R ARRAYS.           * VOLAR     30
C*                                                                    * VOLAR     31
C********************************************************************** VCLAR     32
      READ(5,SEGMNT)                                                    VOLAR     33
C  *                                                                    VCLAR     34
C  ***   CONVERT I ARRAY SEGMENT DESCRIPTORS TC RELATIVE FWAS.          VCLAR     35
C  *                                                                    VOLAR     36
      IF(NPRNT .NE. 0) WRITE(6,25002)                                   VOLAR     37
      I      = 1                                                        VCLAR     38
      J      = NI(I)                                                    VCLAR     39
      NI(I) = 0                                                         VOLAR     40
      IF(NPRNT .NE. 0) WRITE(6,31004) I,NI(I),J                         VCLAR     41
      DO 10 I=2,NSEGI                                                   VCLAR     42
      K      = J                                                        VOLAR     43
      J      = NI(I)                                                    VOLAR     44
      NI(I) = NI(I-1) + K                                               VCLAR     45
      IF(NPRNT .NE. 0) WRITE(6,31004) I,NI(I),J                      VOLAR      46
   10 CONTINUE                                                       VOLAR      47
C  *                                                                 VOLAR      48
C  ***   CONVERT R ARRAY SEGMENT DESCRIPTORS TO RELATIVE FWAS.       VOLAR      49
C  *                                                                 VOLAR      50
      IF(NPRNT .NE. 0) WRITE(6,31002)                                VOLAR      51
      I     = 1                                                      VOLAR      52
      J     = NR(I)                                                  VOLAR      53
      NR(I) = 0                                                      VOLAR      54
      IF(NPRNT .NE. 0) WRITE(6,31004) I,NR(I),J                      VOLAR      55
      DO 20 I=2,NSEGR                                                VOLAR      56
      K     = J                                                      VOLAR      57
      J     = NR(I)                                                  VOLAR      58
      NR(I) = NR(I-1) + K                                            VOLAR      59
      IF(NPRNT .NE. 0) WRITE(6,31004) I,NR(I),J                      VOLAR      60
   20 CONTINUE                                                       VOLAR      61
C********************************************************************** VOLAR      62
C*                                                                  * VOLAR      63
C*OPTION CONTROL                                                    * VOLAR      64
C*                                                                  * VOLAR      65
C*  NOPT = 1 - WRITE I AND R ARRAY I/O INSTRUCTIONS ON A FILE.      * VOLAR      66
C*         2 - READ  DATA INTO I ARRAY AND WRITE THE INPUT ON A FILE. * VOLAR    67
C*         3 - PRINT DATA FROM I ARRAY.                             * VOLAR      68
C*         4 - READ  DATA INTO R ARRAY AND WRITE THE INPUT ON A FILE. * VOLAR    69
C*         5 - PRINT DATA FROM R ARRAY.                             * VOLAR      70
C*         6 - SET UP DIFFERENTIAL EQUATIONS.                       * VOLAR      71
C*         7 - DESIGNATE TIME HISTORY OUTPUT VARIABLES.             * VOLAR      72
C*       8-9 - INACTIVE.                                            * VOLAR      73
C*        10 - READ DATA FROM INPUT AND WRITE A FILE COMPATIBLE FOR * VOLAR      74
C*             OPTIONS 14, 15, 17 AND 18.                           * VOLAR      75
C*        11 - STORE TABBING OR PUNCHING INSTRUCTIONS ON A FILE.    * VOLAR      76
C*        12 - STORE PRINTER PLOTTING INSTRUCTIONS ON A FILE.       * VOLAR      77
C*        13 - STORE CALCOMP PLOTTING INSTRUCTIONS ON A FILE.       * VOLAR      78
C*        14 - PRINT THE TIME HISTORY IN A TABULAR FORM.            * VOLAR      79
C*        15 - PUNCH TIME HISTORY OUTPUT.                           * VOLAR      80
C*        16 - INACTIVE.                                            * VOLAR      81
C*        17 - PRODUCE PRINTER PLOT.                                * VOLAR      82
C*        18 - PRODUCE CALCOMP PLOT.                                * VOLAR      83
C*        19 - PRINT A TIME HISTORY FILE IN BLOCKED FORM.           * VOLAR      84
C*        21 - GENERATE A TIME HISTORY (MEANS AND/OR COVARIANCES).  * VOLAR      85
C*     22-27 - INACTIVE                                             * VOLAR      86
C*        28 - STORE OR RETRIEVE R ARRAY ON TAPE28                  * VOLAR      87
C*                                                                  * VOLAR      88
C********************************************************************** VOLAR      89
  100 READ(5,34012) NOPT,LBLOUT                                      VOLAR      90
      IF(NOPT.EQ.0.OR.EOF(5).NE.0.0) STOP                            VOLAR      91
      WRITE(6,34011) NOPT,LBLOUT                                     VOLAR      92
      GO TO ( 30001 , 30002 , 30003 , 30004 , 30005 , 30006 , 30007 , VOLAR     93
     1          100 ,   100 , 30010 , 30011 , 30012 , 30013 , 30014 , VOLAR     94
     2        30015 ,   100 , 30017 , 30018 , 30019 ,   100 , 30021 , VOLAR     95
     3          100 ,   100 ,   100 ,   100 ,   100 ,   100 , 30028 ), VOLAR    96
     4 NOPT                                                          VOLAR      97
C********************************************************************** VOLAR      98
C*                                                                  * VOLAR      99
C*NOPT=1  WRITE I AND R ARRAY I/O INSTRUCTIONS ON A FILE.           * VOLAR     100
C*                                                                  * VOLAR     101
C*   DEFINITIONS                                                    * VOLAR     102
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      C*        NLIST      FILE WHERE INSTRUCTIONS WILL RESIDE.                  * VOLAR     103
      C*        I,J        J TH ELEMENT I TH SEGMENT OF I OR R ARRAY.            * VOLAR     104
      C*        K,L        L TH ELEMENT K TH SEGMENT OF I OR R ARRAY.            * VOLAR     105
      C*        I,J,K,L    I/O FROM I,J TO K,L LOCATION OF I OR R ARRAY.         * VOLAR     106
      C*        LABEL      VARIABLE NAMES APPEARING BETWEEN I,J AND K,L.         * VOLAR     107
      C*        SCALE      SCALE FACTOR APPLIED TO I/O VALUES (DEFAULT=1.0).     * VOLAR     108
      C*        FMTI       VARIABLE INPUT FORMAT.                                * VOLAR     109
      C*        FMTO       VARIABLE OUTPUT FORMAT.                               * VOLAR     110
      C*                                                                         * VOLAR     111
      C*   OPTION IS TERMINATED BY A BLANK CARD.                                 * VOLAR     112
      C*                                                                         * VOLAR     113
      C************************************************************************** VOLAR     114
      30001 READ(5,31001) NLIST                                                    VOLAR     115
            WRITE(6,23001)NLIST                                                    VOLAR     116
            REWIND NLIST                                                           VOLAR     117
      200   READ(5,31008) I,J,K,L,LABEL,SCALE                                      VOLAR     118
            WRITE(6,31009)I,J,K,L,LABEL,SCALE                                      VOLAR     119
            IF(I.LT.0) READ(5,26002) FMTI,FMTO                                     VOLAR     120
            IF(I.LT.0) WRITE(6,26003)FMTI,FMTO                                     VOLAR     121
            WRITE(NLIST) I,J,K,L,LABEL,SCALE                                       VOLAR     122
            IF(I.LT.0) WRITE(NLIST) FMTI,FMTO                                      VOLAR     123
            IF(I.NE.0) GO TO 200                                                   VOLAR     124
            GO TO 100                                                              VOLAR     125
      C************************************************************************** VOLAR     126
      C*                                                                         * VOLAR     127
      C*NOPT=2  READ DATA INTO I ARRAY AND WRITE INPUT ONTO A FILE.              * VOLAR     128
      C*                                                                         * VOLAR     129
      C*   DEFINITIONS                                                           * VOLAR     130
      C*        NLIST      CONTAINS INPUT INSTRUCTIONS.                          * VOLAR     131
      C*        NDATA      CONTAINS I ARRAY DATA.                                * VOLAR     132
      C*        NPF        PERMANENT FILE FOR SAVING INPUT.                      * VOLAR     133
      C*        I,J        J TH ELEMENT I TH SEGMENT OF I ARRAY.                 * VOLAR     134
      C*        K,L        L TH ELEMENT K TH SEGMENT OF I ARRAY.                 * VOLAR     135
      C*        I,J,K,L    READ I,J TO K,L LOCATIONS OF I ARRAY.                 * VOLAR     136
      C*        LABEL      VARIABLE NAMES APPEARING BETWEEN I,J AND K,L.         * VOLAR     137
      C*        SCALE      SCALE FACTOR APPLIED TO INPUT VALUES (DEFAULT=1.0).* VOLAR     138
      C*        FMTI       VARIABLE INPUT FORMAT.                                * VOLAR     139
      C*        FMTO       VARIABLE OUTPUT FORMAT.                               * VOLAR     140
      C*                                                                         * VOLAR     141
      C*   OPTION IS TERMINATED BY A BLANK CARD.                                 * VOLAR     142
      C*                                                                         * VOLAR     143
      C************************************************************************** VOLAR     144
      30002 READ(5,31001) NLIST,NDATA,NPF                                          VOLAR     145
            WRITE(6,25010)NLIST,NDATA,NPF                                          VOLAR     146
            IF(NLIST.NE.5) REWIND NLIST                                            VOLAR     147
            IF(NDATA.NE.5) REWIND NDATA                                            VOLAR     148
            IF(NPF.NE.0)   FEWIND NPF                                              VOLAR     149
            FMTI(1) = 10H(16I5)                                                    VOLAR     150
            FMTO(1) = 10H(5X,16I5)                                                 VOLAR     151
      11    IF(NLIST.EQ.5) READ(5,31008) I,J,K,L,LABEL,SCALE                       VOLAR     152
            IF(NLIST.NE.5) READ(NLIST)   I,J,K,L,LABEL,SCALE                       VOLAR     153
            IF(NPF.NE.0)   WRITE(NPF)    I,J,K,L,LABEL,SCALE                       VOLAR     154
            WRITE(6,31009)               I,J,K,L,LABEL,SCALE                       VOLAR     155
            IF(I.EQ.0) GO TO 100                                                   VOLAR     156
            IF(1.GT.0) GO TO 12                                                    VOLAR     157
            IF(NLIST.EQ.5) READ(5,26002) FMTI,FMTO                                 VOLAR     158
            IF(NLIST.NE.5) READ(NLIST)   FMTI,FMTO                                 VOLAR     159
      IF(NPF.NE.0)    WRITE(NPF)     FMTI,FMTO                             VOLAR   160
      WRITE(6,26003)                 FMTI,FMTO                             VCLAR   161
      I       = IABS(I)                                                    VOLAR   162
 12   K1      = NI(I) + J                                                  VOLAR   163
      K2      = NI(K) + L                                                  VOLAR   164
      IF(NDATA.EQ.5) READ(5,FMTI)    (IN(I),I=K1,K2)                       VOLAR   165
      IF(NDATA.NE.5) READ(NDATA)     (IN(I),I=K1,K2)                       VOLAR   166
      IF(NPF.NE.0)    WRITE(NPF)     (IN(I),I=K1,K2)                       VCLAR   167
      WRITE(6,FMTO)                  (IN(I),I=K1,K2)                       VCLAR   168
      IF(SCALE.EQ.0.0) GO TO 11                                            VOLAP   169
      DO 13 I=K1,K2                                                        VCLAR   170
      IN(I)   = SCALE*IN(I)                                                VOLAR   171
 13   CONTINUE                                                             VCLAR   172
      GO TO 11                                                             VCLAR   173
C************************************************************************* VOLAP   174
C*                                                                       * VCLAR   175
C*NOPT=3  PRINT DATA FROM I ARRAY.                                       * VOLAR   176
C*                                                                       * VCLAR   177
C*   DFFINITIONS                                                         * VCLAR   178
C*        NLIST      FILE WHERE WRITE INSTRUCTIONS RESIDE.               * VOLAR   179
C*        I,J        J TH ELEMENT I TH SEGMENT OF I ARRAY.               * VOLAR   180
C*        K,L        L TH ELEMENT K TH SEGMENT OF I ARRAY.               * VOLAR   181
C*        I,J,K,L    WRITE I,J TO K,L LOCATIONS OF I ARRAY.              * VCLAR   182
C*        LABEL      VARIABLE NAMES APPEARING BETWEEN I,J AND K,L.       * VOLAR   183
C*        SCALE      SCALE FACTOR TO BE APPLIED TO OUTPUT VALUES.        * VCLAR   184
C*        FMTO       VARIABLE OUTPUT FORMAT.                             * VOLAR   185
C*                                                                       * VOLAR   186
C*   OPTION IS TERMINATED BY A BLANK CARD.                               * VCLAR   187
C*                                                                       * VOLAR   188
C************************************************************************* VOLAR   189
30003 READ(5,31001) NLIST                                                  VOLAR   190
      WRITF(6,23001)NLIST                                                  VCLAR   191
      IF(NLIST.NE.5) REWIND NLIST                                          VOLAR   192
      FMTO(1) = 10H(5X,16I5)                                               VOLAR   193
 31   IF(NLIST.EQ.5) READ(5,31008) I,J,K,L,LABEL,SCALE                     VOLAR   194
      IF(NLIST.NE.5) READ(NLIST)    I,J,K,L,LABEL,SCALE                    VOLAR   195
      WRITE(6,31009)                I,J,K,L,LABEL,SCALE                    VOLAR   196
      IF(I.EQ.0) GO TO 100                                                 VOLAR   197
      IF(I.GT.0) GO TO 32                                                  VOLAR   198
      IF(NLIST.EQ.5) READ(5,26002) FMTO                                    VOLAR   199
      IF(NLIST.NE.5) READ(NLIST)    FMTO                                   VOLAR   200
      WRITE(6,26003)                FMTO                                   VCLAR   201
      I       = IABS(I)                                                    VOLAR   202
 32   K1      = NI(I) + J                                                  VOLAR   203
      K2      = NI(K) + L                                                  VOLAR   204
      IF(SCALE.EQ.0.0) GO TO 34                                            VOLAR   205
      DO 33 I=K1,K2                                                        VCLAR   206
      IN(I)   = SCALE*IN(I)                                                VCLAR   207
 33   CONTINUE                                                             VOLAR   208
 34   WRITE(6,FMTO)                 (IN(I),I=K1,K2)                        VOLAR   209
      IF(SCALE.EQ.0.0) GO TO 31                                            VOLAP   210
      SCALE   = 1.0/SCALE                                                  VOLAR   211
      DO 35 I=K1,K2                                                        VCLAR   212
      IN(I)   = SCALE*IN(I)                                                VOLAR   213
 35   CONTINUE                                                             VOLAR   214
      GO TO 31                                                             VOLAR   215
C************************************************************************* VOLAR   216
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      C*                                                                        * VOLAR  217
      C*NOPT=4  READ DATA INTO R ARRAY AND WRITE INPUT ON A FILE.               * VOLAR  218
      C*                                                                        * VOLAR  219
      C*  DEFINITIONS                                                           * VOLAR  220
      C*        NLIST      FILE WHERE INPUT INSTRUCTIONS RESIDE.                * VOLAR  221
      C*        NDATA      FILE CONTAINING R ARRAY DATA.                        * VOLAR  222
      C*        NPF        PERMANENT FILE FOR SAVING INPUT.                     * VOLAR  223
      C*        I,J        J TH ELEMENT I TH SEGMENT OF R ARRAY.                * VOLAR  224
      C*        K,L        L TH ELEMENT K TH SEGMENT OF R ARRAY.                * VOLAR  225
      C*        I,J,K,L    READ I,J TO K,L LOCATIONS OF R ARRAY.                * VOLAR  226
      C*        LABEL      VARIABLE NAMES APPEARING BETWEEN I,J AND K,L.        * VOLAR  227
      C*        SCALE      SCALE FACTOR TO BE APPLIED TO INPUT VARIABLES.       * VOLAR  228
      C*        FMTI       VARIABLE INPUT FORMAT.                               * VOLAR  229
      C*        FMTO       VARIABLE OUTPUT FORMAT.                              * VOLAR  230
      C*                                                                        * VOLAR  231
      C*  OPTION IS TERMINATED BY A BLANK CARD.                                 * VOLAR  232
      C*                                                                        * VOLAR  233
      C*  CODE MAY BE ENTERED AT STMT 310 BY OPTION 21 - EXITS TO STMT 1100.    * VOLAR  234
      C*                                                                        * VOLAR  235
      C************************************************************************** VOLAR  236
      30C04 READ(5,31001) NLIST,NDATA,NPF                                         VOLAR  237
            WRITE(6,31013)NLIST,NDATA,NPF                                         VOLAR  238
      310   IF(NLIST.NE.5) REWIND NLIST                                           VOLAR  239
            IF(NDATA.NE.5) REWIND NDATA                                           VOLAR  240
            IF(NPF.NE.0)   REWIND NPF                                             VOLAR  241
            FMTI(1) = 10H(7F10.3)                                                 VOLAR  242
            FMTO(1) = 10H(7F14.5)                                                 VOLAR  243
      301   IF(NLIST.EQ.5) READ(5,31008) I,J,K,L,LABEL,SCALE                      VOLAR  244
            IF(NLIST.NE.5) READ(NLIST)   I,J,K,L,LABEL,SCALE                      VOLAR  245
            IF(NPF.NE.0)   WRITE(NPF)    I,J,K,L,LABEL,SCALE                      VOLAR  246
            WRITE(6,31009)               I,J,K,L,LABEL,SCALE                      VOLAR  247
            IF(I.EQ.0.AND.NOPT.EQ.4) GO TO 100                                    VOLAR  248
            IF(I.EQ.0) GO TO 1100                                                 VOLAR  249
            IF(I.GT.0) GO TO 302                                                  VOLAR  250
            IF(NLIST.EQ.5) READ(5,26002) FMTI,FMTO                                VOLAR  251
            IF(NLIST.NE.5) READ(NLIST)   FMTI,FMTO                                VOLAR  252
            IF(NPF.NE.0)   WRITE(NPF)    FMTI,FMTO                                VOLAR  253
            WRITE(6,26003)               FMTI,FMTO                                VOLAR  254
            I     = IABS(I)                                                       VOLAR  255
      302   K1    = NR(I) + J                                                     VOLAR  256
            K2    = NR(K) + L                                                     VOLAR  257
            IF(NDATA.EQ.5) READ(5,FMTI)  (R(I),I=K1,K2)                           VOLAR  258
            IF(NDATA.NE.5) READ(NDATA)   (R(I),I=K1,K2)                           VOLAR  259
            IF(NPF.NE.0)   WRITE(NPF)    (R(I),I=K1,K2)                           VOLAR  260
            WRITE(6,FMTO)                (R(I),I=K1,K2)                           VOLAR  261
            IF(SCALE.EQ.0.0) GO TO 301                                            VOLAR  262
            DO 303 I=K1,K2                                                        VOLAR  263
            R(I)  = SCALE*R(I)                                                    VOLAR  264
      303   CONTINUE                                                              VOLAR  265
            GO TO 301                                                             VOLAR  266
      C************************************************************************** VOLAR  267
      C*                                                                        * VOLAR  268
      C*NOPT=5  PRINT DATA FROM R ARRAY.                                        * VOLAR  269
      C*                                                                        * VOLAR  270
      C*  DEFINITIONS                                                           * VOLAR  271
      C*        NTAP       FILE WHERE WRITE INSTRUCTIONS RESIDE.                * VOLAR  272
      C*        I,J        J TH ELEMENT I TH SEGMENT OF R ARRAY.                * VOLAR  273
      C*     K,L         L TH ELEMENT K TH SEGMENT OF R ARRAY.                   * VOLAR   274
      C*     I,J,K,L     WRITE I,J TO K,L LOCATIONS OF R ARRAY.                  * VOLAR   275
      C*     LABEL       VARIABLE NAMES APPEARING BETWEEN I,J AND K,L.           * VOLAR   276
      C*     SCALE       SCALE FACTOR TO BE APPLIED TO OUTPUT VARIABLES.         * VOLAR   277
      C*     FMTO        VARIABLE OUTPUT FORMAT.                                 * VOLAR   278
      C*                                                                         * VOLAR   279
      C*  OPTION IS TERMINATED BY A BLANK CARD.                                  * VOLAR   280
      C*                                                                         * VOLAR   281
      C*  CODE MAY BE ENTERED AT STMT 402 BY OPTION 21 - EXITS TO STMT 1111.* VOLAR   282
      C*                                                                         * VOLAR   283
      C************************************************************************** VOLAR   284
      30005 READ(5,31001) NTAP                                                     VOLAR   285
            WRITE(6,23001)NTAP                                                     VOLAR   286
        402 IF(NTAP.NE.5) REWIND NTAP                                              VOLAR   287
            FMTO(1) = 10H(7E14.5)                                                  VOLAR   288
        403 IF(NTAP.EQ.5) READ(5,31008)  I,J,K,L,LABEL,SCALE                       VOLAR   289
            IF(NTAP.NE.5) READ(NTAP)     I,J,K,L,LABEL,SCALE                       VOLAR   290
            WRITE(6,31009)               I,J,K,L,LABEL,SCALE                       VOLAR   291
            IF(I.EQ.0.AND.NOPT.EQ.5) GO TO 100                                     VOLAR   292
            IF(I.EQ.0) GO TO 1111                                                  VOLAR   293
            IF(I.GT.0) GO TO 404                                                   VOLAR   294
            IF(NTAP.EQ.5) READ(5,26002) FMTO                                       VOLAR   295
            IF(NTAP.NE.5) READ(NTAP)    FMTO                                       VOLAR   296
            WRITE(6,26003)              FMTO                                       VOLAR   297
            I        = IABS(I)                                                     VOLAR   298
        404 K1       = NR(I) + J                                                   VOLAR   299
            K2       = NR(K) + L                                                   VOLAR   300
            IF(SCALE.EQ.0.0) GO TO 406                                             VOLAR   301
            DO 405 I=K1,K2                                                         VOLAR   302
            R(I)     = SCALE*R(I)                                                  VOLAR   303
        405 CONTINUE                                                               VOLAR   304
        406 WRITE(6,FMTO)              (R(I),I=K1,K2)                              VOLAR   305
            IF(SCALE.EQ.0.0) GO TO 403                                             VOLAR   306
            SCALE    = 1.0/SCALE                                                   VOLAR   307
            DO 407 I=K1,K2                                                         VOLAR   308
            R(I)     = SCALE*R(I)                                                  VOLAR   309
        407 CONTINUE                                                               VOLAR   310
            GO TO 403                                                              VOLAR   311
      C************************************************************************** VOLAR   312
      C*                                                                         * VOLAR   313
      C*NOPT=6  SET UP DIFFERENTIAL EQUATIONS.                                   * VOLAR   314
      C*                                                                         * VOLAR   315
      C*   DEFINITIONS                                                           * VOLAR   316
      C*     M,J         J TH ELEMENT M TH SEGMENT OF I ARRAY WHERE R ARRAY * VOLAR   317
      C*                 LOCATIONS OF DIFFERENTIAL EQUATION ELEMENTS WILL        * VOLAR   318
      C*                 BE STORED.                                              * VOLAR   319
      C*     I,J         J TH ELEMENT I TH SEGMENT OF R ARRAY.                   * VOLAR   320
      C*     K,L         L TH ELEMENT K TH SEGMENT OF R ARRAY.                   * VOLAR   321
      C*     I,J,K,L     LOCATIONS I,J THRU K,L OF R ARRAY CONTAIN               * VOLAR   322
      C*                 DIFFERENTIAL EQUATION ELEMENTS WHOSE LOCATION WILL * VOLAR   323
      C*                 BE STORED IN THE NEXT SEQUENTIAL LOCATIONS OF THE  * VOLAR   324
      C*                 I ARRAY BEGINNING WITH M,J.                             * VOLAR   325
      C*     LABEL       R ARRAY VARIABLE NAMES BETWEEN I,J AND K,L.             * VOLAR   326
      C*                                                                         * VOLAR   327
      C*  OPTION WILL BE TERMINATED BY A BLANK CARD.                             * VOLAR   328
      C*                                                                         * VOLAR   329
      C************************************************************************** VOLAR   330
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30006 NTAP   = 1                                                           VOLAR     331
1201  READ(5,31008) M,J                                                    VOLAR     332
      IF(NTAP.EQ.1) WRITE(6,27002) M,J                                     VOLAR     333
      IF(NTAP.EQ.2) WRITE(6,27003) M,J                                     VOLAR     334
      IF(NTAP.EQ.3) WRITE(6,27004) M,J                                     VOLAR     335
      IF(NTAP.EQ.4) WRITE(6,27005) M,J                                     VOLAR     336
      IF(NTAP.EQ.5) WRITE(6,27006) M,J                                     VOLAR     337
      M      = NI(M) + J - 1                                               VOLAR     338
1202  READ(5,31008) I,J,K,L,LABEL                                          VOLAR     339
      WRITE(6,31005)I,J,K,L,LABEL                                          VOLAR     340
      IF(I.EQ.0) GO TO 1205                                                VOLAR     341
      K1     = NR(I) + J                                                   VOLAR     342
      K2     = NR(K) + L                                                   VOLAR     343
      IF(NTAP.GE.3) GO TO 1204                                             VOLAR     344
      DO 1203 I=K1,K2                                                      VOLAR     345
      M      = M + 1                                                       VOLAR     346
      IN(M) = I                                                            VOLAR     347
1203  CONTINUE                                                             VOLAR     348
      GO TO 1202                                                           VOLAR     349
1204  M      = M + 1                                                       VOLAR     350
      IN(M) = K1                                                           VOLAR     351
      M      = M + 1                                                       VOLAR     352
      IN(M) = K2                                                           VOLAR     353
      GO TO 1202                                                           VOLAR     354
1205  NTAP   = NTAP + 1                                                    VOLAR     355
      IF(NTAP.GT.5) GO TO 100                                              VOLAR     356
      GO TO 1201                                                           VOLAR     357
C********************************************************************** VOLAR     358
C*                                                                     * VOLAR     359
C*NOPT=7  DESIGNATE TIME HISTORY OUTPUT VARIABLES.                      * VOLAR     360
C*                                                                     * VOLAR     361
C*   DEFINITIONS                                                       * VOLAR     362
C*       I,J          J TH ELEMENT I TH SEGMENT OF R ARRAY.            * VOLAR     363
C*       K,L          L TH ELEMENT K TH SEGMENT OF R ARRAY.            * VOLAR     364
C*       I,J,K,L      LOCATIONS I,J THRU K,L OF R ARRAY ARE TO BE OUTPUT * VOLAR     365
C*                    WITH TIME HISTORY INFORMATION.                   * VOLAR     366
C*       LABEL        R ARRAY VARIABLE NAMES BETWEEN I,J AND K,L.      * VOLAR     367
C*                                                                     * VOLAR     368
C*   OPTION WILL BE TERMINATED BY A BLANK CARD.                        * VOLAR     369
C*                                                                     * VOLAR     370
C*   MAX OF 200 VARIABLES MAY BE SPECIFIED AS OUTPUT VARIABLES.        * VOLAR     371
C*                                                                     * VOLAR     372
C********************************************************************** VOLAR     373
30007 NOUT   = 0                                                           VOLAR     374
      M      = 0                                                           VOLAR     375
40    READ(5,25006) I,J,K,L,LABEL                                          VOLAR     376
      WRITE(6,25007)I,J,K,L,LABEL                                          VOLAR     377
      IF(I.EQ.0) GO TO 100                                                 VOLAR     378
      K1     = NR(I) + J                                                   VOLAR     379
      K2     = NR(K) + L                                                   VOLAR     380
      DO 42 I=K1,K2                                                        VOLAR     381
      NOUT   = NOUT + 1                                                    VOLAR     382
      IF(NOUT.GT.200) GO TO 41                                             VOLAR     383
      IO(NOUT)= I                                                          VOLAR     384
      GO TO 42                                                             VOLAR     385
41    M      = M + 1                                                       VOLAR     386
      IF(M.EQ.1) WRITE(6,33001)                                            VOLAR     387
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            NOUT    = 200                                                       VOLAR      388
      42    CONTINUE                                                            VOLAR      389
            GO TO 40                                                            VOLAR      390
C*************************************************************************** VOLAR      391
C*                                                                         * VOLAR      392
C*NOPT=10  READ DATA FROM INPUT AND WRITE A FILE COMPATIBLE FOR            * VOLAR      393
C*         OPTIONS 14, 15, 17 AND 18.                                      * VOLAR      394
C*                                                                         * VOLAR      395
C*    DEFINITIONS                                                          * VOLAR      396
C*       NLIST        FILE WHERE DATA WILL RESIDE.                         * VOLAR      397
C*       K1           NUMBER OF ROWS OF DATA.                              * VOLAR      398
C*       K2           NUMBER OF COLUMNS OF DATA.                           * VOLAR      399
C*       L            .EQ. 0 IF NUMBER OF POINTS EQUALS NUMBER OF ROWS.    * VOLAR      400
C*                    .NE. 0 IF NUMBER OF POINTS IS INCLUDED IN FIRST      * VOLAR      401
C*                    ROW AS A FLOATING POINT NUMBER.                      * VOLAR      402
C*       ROW(J)       DATA POINTS FOR THE I TH ROW.                        * VOLAR      403
C*                                                                         * VOLAR      404
C*    OPTION IS TERMINATED WHEN LAST ROW HAS BEEN READ.                    * VOLAR      405
C*                                                                         * VOLAR      406
C*    MAX ALLOWABLE VALUE FOR K2 IS 200.                                   * VOLAR      407
C*                                                                         * VOLAR      408
C*************************************************************************** VOLAR      409
30010 READ(5,31001) NLIST                                                       VOLAR      410
      WRITE(6,23001)NLIST                                                       VOLAR      411
      REWIND NLIST                                                              VOLAR      412
      READ(5,31001) K1,K2,L                                                     VOLAR      413
      WRITE(NLIST)  K1,K2,L                                                     VOLAR      414
      DO 800 I=1,K1                                                             VOLAR      415
      READ(5,23002) (ROW(J),J=1,K2)                                             VOLAR      416
      WRITE(NLIST)  (ROW(J),J=1,K2)                                             VOLAR      417
  800 CONTINUE                                                                  VOLAR      418
      GO TO 100                                                                 VOLAR      419
C*************************************************************************** VOLAR      420
C*                                                                         * VOLAR      421
C*NOPT=11  STORE TABBING OR PUNCHING INSTRUCTIONS ON A FILE.               * VOLAR      422
C*                                                                         * VOLAR      423
C*    DEFINITIONS                                                          * VOLAR      424
C*       NLIST        FILE WHERE INSTRUCTIONS WILL RESIDE.                 * VOLAR      425
C*       I            .NE. 0 DESIGNATES PUNCHING INSTRUCTIONS.             * VOLAR      426
C*       K1           NUMBER OF COLUMNS IN TABULATION.                     * VOLAR      427
C*       LBLOUT       TITLE FOR TABULATED DATA.                            * VOLAR      428
C*       NTAP         FILE WHERE DATA RESIDES.                             * VOLAR      429
C*       K2           DATA COLUMN TO BE TABBED.                            * VOLAR      430
C*       L            COLUMN HEADING.                                      * VOLAR      431
C*       LABEL        VARIABLE DESCRIPTION.                                * VOLAR      432
C*       SCALE        SCALE FACTOR TO BE APPLIED TO DATA (DEFAULT=1.0).    * VOLAR      433
C*                                                                         * VOLAR      434
C*    OPTION IS TERMINATED BY A BLANK CARD.                                * VOLAR      435
C*                                                                         * VOLAR      436
C*    MAX ALLOWABLE VALUE FOR K1 IS 10.                                    * VOLAR      437
C*                                                                         * VOLAR      438
C*************************************************************************** VOLAR      439
30011 READ(5,31001) NLIST,I                                                     VOLAR      440
      WRITE(6,32001)NLIST,I                                                     VOLAR      441
      IF(I.NE.0) GO TO 501                                                      VOLAR      442
  500 READ(5,23006) K1,LBLOUT                                                   VOLAR      443
      WRITE(6,23007)K1,LBLOUT                                                   VOLAR      444
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            WRITE(NLIST)  K1,LBLOUT                                                       VCLAP   445
            IF(K1.EQ.0) GO TO 100                                                         VOLAR   446
      501   K       = C                                                                   VOLAR   447
      502   READ(5,32CC2) NTAP,K2,L,LABEL,SCALE                                           VCLAR   448
            WRITE(6,32003)NTAP,K2,L,LABEL,SCALE                                           VOLAR   449
            WRITE(NLIST)  NTAP,K2,L,SCALE                                                 VOLAR   450
            K       = K + 1                                                               VCLAR   451
            IF(K.EQ.K1.AND.I.EQ.0) GO TO 500                                              VOLAP   452
            IF(K2.GT.0) GO TO 502                                                         VCLAR   453
            GO TO 100                                                                     VCLAR   454
      C****************************************************************************** VOLAR   455
      C*                                                                            * VCLAP   456
      C*NOPT=12   STORE PRINTER PLOTTER INSTRUCTIONS ON A FILE.                     * VCLAR   457
      C*                                                                            * VCLAP   458
      C*   DEFINITIONS                                                              * VOLAR   459
      C*        NLIST       FILE WHERE PLOT INSTRUCTIONS WILL RESIDE.               * VOLAR   460
      C*        K1          NUMBER OF PLOTS TO BE PRODUCED.                         * VOLAR   461
      C*   DEFINITIONS FOR PLOT DATA                                                * VOLAR   462
      C*        DELX        INCREMENT PER INCH ON X AXIS.                           * VCLAR   463
      C*        DELY        INCREMENT PER INCH ON Y AXIS.                             VOLAR   464
      C*        FMTI        X AXIS LABEL.                                           * VOLAR   465
      C*        FMTO        Y AXIS LABEL.                                           * VCLAR   466
      C*        NCURVS      NUMBER OF CURVES TO BE PRODUCED ON A PLOT.              * VCLAR   467
      C*        TITLE       3-CARD PLOT TITLE.                                      * VCLAR   468
      C*        STARTX      X VALUE AT AXIS INTERSECTION.                           * VCLAR   469
      C*        STARTY      Y VALUE AT AXIS INTERSECTION.                           * VCLAR   470
      C*        XPLOT       NUMBER OF INCHES FROM LEFT TO PLACE *STARTX*.           * VCLAR   471
      C*        YPLOT       NUMBER OF INCHES FROM TOP TO PLACE *STARTY*.            * VOLAR   472
      C*   DEFINITIONS FOR CURVE DATA                                               * VCLAR   473
      C*        LABEL       LEGEND ASSOCIATED WITH A CURVE.                         * VCLAR   474
      C*        NCOLX       COLUMN WHERE DATA FOR X IS LOCATED.                     * VCLAR   475
      C*        NCOLY       COLUMN WHERE DATA FOR Y IS LOCATED.                     * VCLAR   476
      C*        NDATA       FILE WHERE DATA FOR CURVE RESIDES.                      * VCLAR   477
      C*        SCALEX      SCALE FACTOR FOR X (DEFAULT=1.0).                       * VCLAR   478
      C*        NSYM        PLOTTING SYMBOL.                                        * VOLAR   479
      C*        SCALEY      SCALE FACTOR FOR Y (DEFAULT=1.0).                       * VOLAR   480
      C*                                                                            * VOLAR   481
      C****************************************************************************** VOLAR   482
      30012 READ(5,31001)       NLIST                                                     VOLAR   483
            WRITE(6,23001)      NLIST                                                     VOLAR   484
            READ(5,31001)       K1                                                        VOLAR   485
            WRITE(6,31005)      K1                                                        VCLAR   486
            REWIND NLIST                                                                  VCLAR   487
            WRITE(NLIST,31001) K1                                                         VCLAR   488
      C  *                                                                                VCLAR   489
      C  ***     READ DATA FOR EACH PLOT.                                                 VOLAR   490
            DO 2001 I=1,K1                                                                VOLAR   491
            READ(5,24002)       (TITLE(J),J=1,24)                                         VCLAP   492
            WRITE(6,24006)      (TITLE(J),J=1,24)                                         VCLAR   493
            WRITE(NLIST,24007)  (TITLE(J),J=1,24)                                         VCLAR   494
            READ(5,24003)       NCURVS,XPLOT,YPLOT,DELX,DELY,STARTX,STARTY                VCLAR   495
            WRITE(6,24004)      NCURVS,XPLOT,YPLCT,DFLX,DFLY,STARTX,STARTY                VCLAR   496
            WRITE(NLIST,24003)  NCURVS,XPLCT,YPLOT,DELX,DELY,STARTX,STARTY                VCLAR   497
            READ(5,24002)       FMTI,FMTO                                                 VCLAR   498
            WRITE(6,24006)      FMTI,FMTO                                                 VCLAR   499
            WRITE(NLIST,24002)  FMTI,FMTO                                                 VCLAR   500
      C  ***     READ CURVE DATA.                                                         VOLAR   501
      DO 2000 J=1,NCURVS                                                VOLAR   502
      READ(5,25021)      (LABEL(K),K=1,4),NDATA,NCOLX,NCOLY,NSYM,SCALEX, VOLAR   503
     1                   SCALEY                                          VOLAR   504
      WRITE(6,25022)     (LABEL(K),K=1,4),NDATA,NCOLX,NCOLY,NSYM,SCALEX, VOLAR   505
     1                   SCALEY                                          VOLAR   506
      WRITE(NLIST,25021) (LABEL(K),K=1,4),NDATA,NCOLX,NCOLY,NSYM,SCALEX, VOLAR   507
     1                   SCALEY                                          VOLAR   508
 2000 CONTINUE                                                           VOLAR   509
 2001 CONTINUE                                                           VOLAR   510
      GO TO 100                                                          VOLAR   511
C*********************************************************************** VOLAR   512
C*                                                                     * VOLAR   513
C*NOPT=13  STORE CALCOMP PLOTTER INSTRUCTIONS ON A FILE.                * VOLAR   514
C*                                                                     * VOLAR   515
C*    DEFINITIONS                                                      * VOLAR   516
C*         K1        NUMBER OF PLOTS TO BE PRODUCED.                   * VOLAR   517
C*         L         =4HC.M. IF PLOTTING ON CENTIMETER PAPER.          * VOLAR   518
C*         NLIST     FILE WHERE PLOTTING INSTRUCTIONS WILL RESIDE.     * VOLAR   519
C*         PCODE     CALCOMP PLOT CODE                                 * VOLAR   520
C*         NTAP      FILE PRODUCED BY CALCOMP                          * VOLAR   521
C*    DEFINITIONS FOR PLOT DATA                                        * VOLAR   522
C*         ANGLE     PLOT ROTATION ANGLE (DEGREES).                    * VOLAR   523
C*         DELX      INCREMENT PER INCH ON X AXIS.                     * VOLAR   524
C*         DELY      INCREMENT PER INCH ON Y AXIS.                     * VOLAR   525
C*         ISOPT     SPECIAL INDICATOR BIT ARRAY.                      * VOLAR   526
C*                   BIT(0)=1 READ TITLE TO BE CENTERED OVER PLOT.     * VOLAR   527
C*                   BIT(1)=1 READ X AXIS LABEL.                       * VOLAR   528
C*                   BIT(2)=1 READ Y AXIS LABEL.                       * VOLAR   529
C*                   BIT(3)=1 READ LEGEND TITLE.                       * VOLAR   530
C*                   BIT(4)=1 READ TITLE AND COORDINATES.              * VOLAR   531
C*         LABELX    LABEL FOR X AXIS.                                 * VOLAR   532
C*         LABELY    LABEL FOR Y AXIS.                                 * VOLAR   533
C*         LEGEND    LEGEND TITLE.                                     * VOLAR   534
C*         LNGTHX    LENGTH OF X AXIS (INCHES).                        * VOLAR   535
C*         LNGTHY    LENGTH OF Y AXIS (INCHES).                        * VOLAR   536
C*         NCURVS    NUMBER OF CURVES APPEARING ON PLOT.               * VOLAR   537
C*         TITLE     3 CARD PLOT TITLE                                 * VOLAR   538
C*         STARTX    FIRST X VALUE.                                    * VOLAR   539
C*         STARTY    FIRST Y VALUE.                                    * VOLAR   540
C*         X         X COORDINATE FOR PLOT TITLE.                      * VOLAR   541
C*         XEXIT     FINAL X PEN MOVEMENT (INCHES).                    * VOLAR   542
C*         XLEGND    X COORDINATE (REL TO XPLOT) OF PLOT LEGEND (INCHES)* VOLAR   543
C*         XORG      X VALUE AT WHICH AXES INTERCEPT.                  * VOLAR   544
C*         XPLOT     DISTANCE (INS) BETWEEN LAST X-AXIS ORG AND PRESENT.* VOLAR   545
C*         Y         Y COORDINATE FOR PLOT TITLE.                      * VOLAR   546
C*         YEXIT     FINAL Y PEN MOVEMENT (INCHES).                    * VOLAR   547
C*         YLEGND    Y COORDINATE (REL TO YPLOT) OF PLOT LEGEND (INCHES)* VOLAR   548
C*         YORG      Y VALUE AT WHICH AXES INTERCEPT.                  * VOLAR   549
C*         YPLOT     DISTANCE (INS) BETWEEN LAST Y-AXIS ORG AND PRESENT.* VOLAR   550
C*    DEFINITIONS FOR CURVE DATA                                       * VOLAR   551
C*         DASH      LENGTH OF PLOTTING SEGMENTS IN DASH PLOT (INCHES). * VOLAR   552
C*         K         LINE STYLE.                                       * VOLAR   553
C*         LINTYP    LINE TYPE.                                        * VOLAR   554
C*                   =0 IF NO SYMBOLS (LINE ONLY).                     * VOLAR   555
C*                   =- IF NO LINE    (SYMBOL ONLY).                   * VOLAR   556
C*                   =+ IF BOTH LINE AND SYMBOL.                       * VOLAR   557
C*         NCOLX     COLUMN ON FILE WHERE X DATA RESIDES.              * VOLAR   558
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      C*       NCOLY     COLUMN ON FILE WHERE Y DATA RESIDES.                  * VOLAR    559
      C*       NCX       COLUMN WHERE X ELLIPTICAL AXIS DATA RESIDES.          * VCLAR    560
      C*       NCY       COLUMN WHERE Y ELLIPTICAL AXIS DATA RESIDES.          * VCLAR    561
      C*       NCXY      COLUMN WHERE XY CROSS CORRELATION DATA RESIDES.       * VCLAR    562
      C*       NDATA     FILE WHERE DATA RESIDES.                              * VCLAR    563
      C*       NSYM      CALCOMP SYMBOL CODE (99 IF ELLIPSE).                  * VDLAR    564
      C*       SCALEX    SCALE FACTOR FOR X DATA (DEFAULT=1.0).                * VCLAR    565
      C*       SCALEY    SCALE FACTOR FOR Y DATA (DEFAULT=1.0).                * VCLAR    566
      C*       SCALXX    SCALE FACTOR FOR X ELLIPTICAL AXIS (DEFAULT=SCALEX)* VOLAR    567
      C*       SCALYY    SCALE FACTOR FOR Y ELLIPTICAL AXIS (DEFAULT=SCALEX)* VOLAR    568
      C*                                                                       * VOLAR    569
      C*********************************************************************** VCLAR    570
      30013 READ(5,31001)          NLIST                                         VOLAR    571
            WRITE(6,23001)         NLIST                                         VOLAR    572
            READ(5,19001) PCODE,NTAP                                             VCLAR    573
            WRITE(6,19002)PCODE,NTAP                                             VCLAR    574
            WRITE(NLIST,19001) PCODE,NTAP                                        VOLAR    575
            READ(5,31025)          K1,L                                          VOLAR    576
            WRITE(6,31005)         K1                                            VOLAR    577
            REWIND NLIST                                                         VOLAR    578
            WRITE(NLIST,31025) K1,L                                              VCLAR    579
      C  *                                                                       VOLAR    580
      C  ***     READ DATA FOR PLOT.                                             VOLAR    581
      C  *                                                                       VOLAR    582
            DO 908 I=1,K1                                                        VOLAR    583
            READ(5,PLOTD)                                                        VCLAR    584
            WRITE(NLIST,PLOTD)                                                   VCLAR    585
            DO 906 J=1,5                                                         VOLAR    586
            K        = ISCPT.AND.SHIFT(MASK(1),J)                                VOLAR    587
            IF(K.EQ.0) GC TO 906                                                 VCLAR    588
            GO TO (901,902,903,904,905),J                                        VCLAR    589
      901   READ(5,24002)          TITLE                                         VOLAR    590
            WRITE(NLIST,24002) TITLE                                             VOLAR    591
            WRITE(6,24006)         TITLE                                         VOLAR    592
            GO TO 906                                                            VOLAR    593
      902   READ(5,24002)          LABELX                                        VOLAR    594
            WRITE(NLIST,24002) LABELX                                            VCLAR    595
            GO TO 906                                                            VOLAR    596
      903   READ(5,24002)          LABELY                                        VOLAR    597
            WRITE(NLIST,24002) LABELY                                            VOLAR    598
            GO TO 906                                                            VOLAR    599
      904   READ(5,24002)          LEGEND                                        VOLAR    600
            WRITE(NLIST,24002) LEGEND                                            VOLAR    601
            WRITE(6,24006)         LEGEND                                        VOLAR    602
            GO TO 906                                                            VOLAR    603
      905   READ(5,24002)          X,Y                                           VCLAR    604
            WRITE(NLIST,24002) X,Y                                               VOLAP    605
            WRITE(6,24006)         X,Y                                           VOLAR    606
            READ(5,24002)          TITLE                                         VOLAR    607
            WRITE(NLIST,24002) TITLE                                             VOLAR    608
            WRITE(6,24006)         TITLE                                         VOLAR    609
      906   CONTINUE                                                             VCLAR    610
            WRITE(6,24007)         NCURVS,XPLOT,YPLOT,XLEGND,YLEGND,ANGLE        VCLAR    611
            WRITE(6,24008)         LABELX,LNGTHX,STARTX,DELX,XORG                VOLAR    612
            WRITE(6,24008)         LABELY,LNGTHY,STARTY,DELY,YORG                VOLAR    613
      C  ***     READ CURVE DATA.                                                VCLAR    614
            DO 907 J=1,NCURVS                                                    VCLAR    615
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          READ(5,CURVE)                                                         VCLAR    616
          WRITE(NLIST,CURVE)                                                    VCLAR    617
          READ(5,24010)       K,(LABEL(L),L=1,4)                                VCLAR    618
          WRITE(NLIST,24010) K,(LABEL(L),L=1,4)                                 VCLAR    619
          WRITE(6,24011)      (LABEL(L),L=1,4),NDATA,NCOLX,NCOLY,NSYM,LINTYP,   VCLAR    620
         1                    DASH,SCALEX,SCALEY,SCALXX,SCALYY                  VCLAR    621
  907     CONTINUE                                                              VCLAR    622
  908     CONTINUE                                                              VCLAR    623
          GO TO 100                                                             VCLAR    624
C*********************************************************************** VCLAR    625
C*                                                                     * VCLAR    626
C*NOPT=14 TAB OUTPUT.                                                   * VCLAR    627
C*                                                                     * VOLAR    628
C*   DEFINITIONS                                                       * VOLAR    629
C*         NLIST      FILE WHERE TAP INSTRUCTIONS RESIDE.              * VCLAR    630
C*         K1         NUMBER LF COLUMNS IN TAPULATION.                 * VOLAR    631
C*         LBLCUT     HEADING FOR TABULATED DATA.                      * VOLAR    632
C*         NFIL(I)    FILE WHERE DATA RESIDES.                         * VCLAR    633
C*         NCOL(I)    DATA COLUMNS TO BE TABBED.                       * VOLAR    634
C*         HDG(I)     COLUMN HEADINGS.                                 * VCLAR    635
C*         SCAL(I)    SCALE FACTOR TO BE APPLIED TO DATA (DEFAULT=1.0). * VOLAR    636
C*         NC(I)      NUMBER OF COLUMNS OF CATA ON I TH FILE.          * VOLAR    637
C*         NP(I)      NUMBER OF POINTS ON I TH FILE.                   * VOLAR    638
C*         K2         NUMBER OF ROWS IN TABULATION.                    * VCLAR    639
C*         ROW(J)     DATA ON J TH ROW OF I TH FILE.                   * VOLAR    640
C*         OUT(J)     TABULAR DATA FOR J TH ROW OF OUTPUT.             * VCLAR    641
C*                                                                     * VOLAR    642
C*   MAX ALLOWABLE VALUE FOR K1 IS 10.                                 * VOLAR    643
C*                                                                     * VCLAR    644
C*   MAX ALLOWABLE VALUE FOR NC(I) IS 200.                             * VOLAR    645
C*                                                                     * VOLAR    646
C*********************************************************************** VCLAR    647
30014 READ(5,31001) NLIST                                               VOLAR    648
      WRITE(6,23001)NLIST                                               VCLAR    649
      REWIND NLIST                                                      VCLAR    650
  601 READ(NLIST)    K1,LBLCUT                                          VOLAR    651
      IF(K1.LE.0) GO TO 100                                             VOLAR    652
      WRITE(6,23005)LBLOUT                                              VOLAR    653
      DO 602 I=1,K1                                                     VOLAR    654
      READ(NLIST)    NFIL(I),NCOL(I),HDG(I),SCAL(I)                     VCLAR    655
  602 CONTINUE                                                          VCLAR    656
      IF(K1.EQ.1) GO TO 605                                             VCLAR    657
C  *                                                                    VCLAR    658
C  ***    MARK MULTIPLE FILE ENTRIES.                                   VCLAR    659
C  *                                                                    VCLAR    660
      L         = K1 - 1                                                VOLAR    661
      DO 604 I=1,L                                                      VOLAR    662
      IF(NFIL(I).LT.0) GO TO 604                                        VCLAR    663
      J         = I + 1                                                 VOLAR    664
      DO 603 K=J,K1                                                     VCLAR    665
      IF(NFIL(K).EQ.NFIL(I)) NFIL(K) = -NFIL(I)                         VCLAR    666
  603 CONTINUE                                                          VCLAR    667
  604 CONTINUE                                                          VOLAR    668
C  *                                                                    VCLAR    669
C  ***    FIND NUMBER OF POINTS ON EACH FILE.                           VOLAR    670
C  *                                                                    VCLAR    671
  605 K2        = 0                                                     VOLAR    672
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      DO 607 I=1,K1
      IF(NFIL(I).LT.0) GO TO 607
      NTAP    = NFIL(I)
      REWIND NTAP
      READ(NTAP)      M,NC(I),L
      K       = NC(I)
      IF(L.NE.0) READ(NTAP) (ROW(J),J=1,K)
      DO 606 J=1,K1
      IF(IABS(NFIL(J)).NE.NFIL(I)) GO TO 606
      NP(J)   = M
      IF(L.NE.0) NP(J) = IFIX(ROW(NCOL(J)) + 0.001)
      IF(NP(J).GT.K2) K2 = NP(J)
  606 CONTINUE
  607 CONTINUE
C  *
C  ***     PRODUCE TABULATION.
C  *
      WRITE(6,32005) (HDG(I),I=1,K1)
      DO 610 I=1,K2
      DO 609 J=1,K1
      IF(NFIL(J).LT.0) GO TO 609
      NTAP    = NFIL(J)
      K       = NC(J)
      READ(NTAP)      (ROW(L),L=1,K)
      IF(EOF(NTAP).NE.0.0) BACKSPACE NTAP
      DO 608 L=1,K1
      IF(IABS(NFIL(L)).NE.NFIL(J)) GO TO 608
      OUT(L)  = 0.0
      IF(I.GT.NP(L)) GO TO 608
      OUT(L)  = ROW(NCOL(L))
      IF(SCAL(L).NE.0.0) OUT(L) = OUT(L)*SCAL(L)
  608 CONTINUE
  609 CONTINUE
      WRITE(6,32006)(OUT(J),J=1,K1)
  610 CONTINUE
      GO TO 601
C*************************************************************************
C*                                                                       *
C*NOPT=15 PUNCH OUTPUT.                                                  *
C*                                                                       *
C*    DEFINITIONS                                                        *
C*         NLIST      FILE WHERE PUNCHING INSTRUCTIONS RESIDE.           *
C*         NTAP       FILE WHERE DATA RESIDES.                           *
C*         K1         DATA COLUMN TO BE PUNCHED.                         *
C*         LABEL(I)   COLUMN HEADING.                                    *
C*         SCALE      SCALE FACTOR TO BE APPLIED TO DATA.                *
C*         K          NUMBER OF ROWS ON DATA FILE.                       *
C*         K2         NUMBER OF COLUMNS ON DATA FILE.                    *
C*         ROW(J)     J TH ROW OF DATA ON FILE.                          *
C*         OUT(I)     DATA FOR I TH PUNCHED CARD.                        *
C*                                                                       *
C*    MAX ALLOWABLE VALUE FOR K1 AND K2 IS 200.                          *
C*                                                                       *
C*************************************************************************
30015 READ(5,31001) NLIST
      WRITE(6,23001)NLIST
      REWIND NLIST
  701 READ(NLIST)    NTAP,K1,LABEL(1),SCALE                               VOLAR    730
      IF(K1.LE.0) GO TO 100                                               VOLAR    731
      REWIND NTAP                                                         VOLAR    732
      READ(NTAP)      K,K2,J                                              VOLAR    733
      IF(J.EQ.0) GO TO 702                                                VOLAR    734
      READ(NTAP)      (ROW(J),J=1,K2)                                     VOLAR    735
      K          = IFIX(ROW(K1) + 0.001)                                  VOLAR    736
  702 M          = 0                                                      VOLAR    737
      L          = 0                                                      VOLAR    738
      DO 703 I=1,K                                                        VOLAR    739
      READ(NTAP)      (ROW(J),J=1,K2)                                     VOLAR    740
      M          = M + 1                                                  VOLAR    741
      OUT(M)     = ROW(K1)                                                VOLAR    742
      IF(SCALE.NE.0.0) OUT(M) = SCALE*OUT(M)                              VOLAR    743
      IF(M.LT.7) GO TO 703                                                VOLAR    744
      L          = L + 1                                                  VOLAR    745
      WRITE(7,32008)(OUT(J),J=1,7),LABEL(1),L                             VOLAR    746
      M          = 0                                                      VOLAR    747
  703 CONTINUE                                                            VOLAR    748
      IF(M.EQ.0) GO TO 701                                                VOLAR    749
      L          = L + 1                                                  VOLAR    750
      M          = M + 1                                                  VOLAR    751
      DO 704 I=M,7                                                        VOLAR    752
      OUT(I)     = 0.0                                                    VOLAR    753
  704 CONTINUE                                                            VOLAR    754
      WRITE(7,32008)(OUT(J),J=1,7),LABEL(1),L                             VOLAR    755
      GO TO 701                                                           VOLAR    756
C************************************************************************ VOLAR    757
C*                                                                      * VOLAR    758
C*NOPT=17 PRINTER PLOT                                                  * VOLAR    759
C*                                                                      * VOLAR    760
C*   DEFINITIONS                                                        * VOLAR    761
C*        NLIST       FILE WHERE PLOT INSTRUCTIONS RESIDE.              * VOLAR    762
C*        NPRNT       =0 IF PLOT INSTRUCTIONS ARE NOT TO BE PLAYED BACK * VOLAR    763
C*                         ON THE OUTPUT FILE.                          * VOLAR    764
C*        ROW         SCRATCH ARRAY USED BY PLOT ROUTINE.               * VOLAR    765
C*                                                                      * VOLAR    766
C************************************************************************ VOLAR    767
30017 READ(5,31001) NLIST,NPRNT                                           VOLAR    768
      WRITE(6,23001)NLIST                                                 VOLAR    769
      CALL PRNPLT(ROW,NLIST,NPRNT)                                        VOLAR    770
      GO TO 100                                                           VOLAR    771
C************************************************************************ VOLAR    772
C*                                                                      * VOLAR    773
C*NOPT=18 CALCOMP PLOT.                                                 * VOLAR    774
C*                                                                      * VOLAR    775
C*   DEFINITIONS                                                        * VOLAR    776
C*        K1          CALCOMP PLOT CODE.                                * VOLAR    777
C*        NLIST       FILE WHERE PLOT INSTRUCTIONS RESIDE.              * VOLAR    778
C*        NPRNT       =0 IF PLOT INSTRUCTIONS ARE NOT TO BE PLAYED BACK * VOLAR    779
C*                         ON THE OUTPUT FILE.                          * VOLAR    780
C*        NTAP        FILE PRODUCED BY CALCOMP.                         * VOLAR    781
C*        ROW         SCRATCH ARRAY USED BY PLOT ROUTINE.               * VOLAR    782
C*                                                                      * VOLAR    783
C************************************************************************ VOLAR    784
30018 READ(5,31001) NLIST,NPRNT                                           VOLAR    785
      WRITE(6,23001)NLIST                                                 VOLAR    786
      READ(5,19001) K1,NTAP                                             VOLAR  787
      WRITE(6,19002)K1,NTAP                                             VOLAR  788
      CALL PLOTS(K1,0,NTAP)                                             VOLAR  789
      CALL CALPLT(ROW,NLIST,NPRNT)                                      VOLAR  790
      GO TO 100                                                         VOLAR  791
C*********************************************************************** VOLAR  792
C*                                                                    * VOLAR  793
C*NOPT=19 PRINT THE TIME HISTORY IN A BLOCKED FORM.                   * VOLAR  794
C*                                                                    * VOLAR  795
C*   DEFINITIONS                                                      * VOLAR  796
C*       NTAP         SCRATCH FILE TO BE PRINTED.                     * VOLAR  797
C*       K1           NUMBER OF ROWS OF DATA ON FILE.                 * VOLAR  798
C*       K2           NUMBER OF COLUMNS OF DATA ON FILE.              * VOLAR  799
C*       M            NO. PASSES THRU FILE REQUIRED TO PRINT ALL COLUMNS.* VOLAR  800
C*       J            FIRST COLUMN OF DATA CURRENTLY BEING PRINTED.   * VOLAR  801
C*       K            LAST COLUMN OF DATA CURRENTLY BEING PRINTED.    * VOLAR  802
C*       ROW(L)       L TH ROW OF DATA ON FILE.                       * VOLAR  803
C*                                                                    * VOLAR  804
C*   OPTION IS TERMINATED BY A BLANK CARD.                            * VOLAR  805
C*                                                                    * VOLAR  806
C*   MAX ALLOWABLE VALUE FOR K2 IS 200.                               * VOLAR  807
C*                                                                    * VOLAR  808
C*********************************************************************** VOLAR  809
30019 READ(5,31001) NTAP                                                VOLAR  810
      WRITE(6,23009)NTAP                                                VOLAR  811
      IF(NTAP.EQ.0) GO TO 100                                           VOLAR  812
      REWIND NTAP                                                       VOLAR  813
      READ(NTAP)     K1,K2,L                                            VOLAR  814
      M          = (K2 + 9)/10                                          VOLAR  815
      DO 560 I=1,M                                                      VOLAR  816
      J          = 10*(I - 1) + 1                                       VOLAR  817
      K          = J + 9                                                VOLAR  818
      IF(K.GT.K2) K = K2                                                VOLAR  819
      DO 550 NLIST=1,K1                                                 VOLAR  820
      READ(NTAP)      (ROW(L),L=1,K2)                                   VOLAR  821
      WRITE(6,23011)(ROW(L),L=J,K)                                      VOLAR  822
  550 CONTINUE                                                          VOLAR  823
      IF(I.EQ.M) GO TO 560                                              VOLAR  824
      REWIND NTAP                                                       VOLAR  825
      READ(NTAP)     K1,K2,L                                            VOLAR  826
  560 CONTINUE                                                          VOLAR  827
      GO TO 30019                                                       VOLAR  828
C*********************************************************************** VOLAR  829
C*                                                                    * VOLAR  830
C*NOPT=21 GENERATE A TIME HISTORY (MEANS AND/OR COVARIANCES)          * VOLAR  831
C*                                                                    * VOLAR  832
C*   DEFINITIONS                                                      * VOLAR  833
C*       TITLE        4-CARD PROBLEM TITLE.                           * VOLAR  834
C*       NLIST        FILE CONTAINING R ARRAY INPUT INSTRUCTIONS.(NOPT=4)* VOLAR  835
C*       NTAP         FILE CONTAINING R ARRAY OUTPUT INSTRUCTIONS(NOPT=5)* VOLAR  836
C*       NDATA        FILE WHERE OUTPUT FROM NOPT=7 WILL RESIDE.      * VOLAR  837
C*       INT          INTEGRATION OPTION.                             * VOLAR  838
C*                    =1 4 TH ORDER RUNGE-KUTTA INTEGRATION.          * VOLAR  839
C*                    =2 3 RD ORDER RUNGE-KUTTA INTEGRATION.          * VOLAR  840
C*                    =3 2 ND ORDER ADAMS INTEGRATION.                * VOLAR  841
C*       NPRNT        .NE. 0 CAUSES DATA TO PRINT AS BLOCK NOT TAB.   * VOLAR  842
C*       TO           INITIAL INTEGRATION TIME.                       * VOLAR  843
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      C*        TI        CURRENT INTEGRATION TIME.                       * VOLAR  844
      C*        DT        DELTA INTEGRATION TIME.                         * VOLAR  845
      C*        DTOUT     DELTA PRINT TIME.                               * VOLAR  846
      C*        DTOUT2    DELTA COVARIANCE MATRIX PRINT TIME.             * VOLAR  847
      C*        TMAX      MAX INTEGRATION TIME.                           * VOLAR  848
      C*                                                                  * VOLAR  849
      C*    EXITS TO STMT 310 OF NOPT=4 TO READ INTEGRATION CONTROL VARIABLES.* VOLAR  850
      C*    RETURNS FROM NOPT=4 AT STMT 1100.                             * VOLAR  851
      C*                                                                  * VOLAR  852
      C*    EXITS TO STMT 402 OF NOPT=5 TO PRINT INITIAL R ARRAY VALUES.  * VOLAR  853
      C*    RETURNS FROM NOPT=5 AT STMT 1111.                             * VOLAR  854
      C*                                                                  * VOLAR  855
      C*********************************************************************** VOLAR  856
      30021 READ(5,26002) TITLE                                             VOLAR  857
            WRITE(6,26003)TITLE                                             VOLAR  858
            READ(5,31001) NLIST,NTAP,NDATA,INT,NPRNT                        VOLAR  859
            WRITE(6,25001)NLIST,NTAP,NDATA,INT,NPRNT                        VOLAR  860
            WRITE(6,34003)                                                  VOLAR  861
            CALL SECOND(SEC1)                                               VOLAR  862
            TO      = TI                                                    VOLAR  863
      C  *                                                                  VOLAR  864
      C  ***      SET UP CALL TO OPTION 4 TO READ INTEGRATION CONTROL VARIABLES. VOLAR  865
      C  *                                                                  VOLAR  866
            N1      = NDATA                                                 VOLAR  867
            NDATA   = 5                                                     VOLAR  868
            NPF     = 0                                                     VOLAR  869
            GO TO 310                                                       VOLAR  870
      C  *                                                                  VOLAR  871
      C  ***      SET UP CALL TO OPTION 5 FOR INITIAL INTEGRATION PRINT.    VOLAR  872
      C  *                                                                  VOLAR  873
      1100  NDATA   = N1                                                    VOLAR  874
            M       = IFIX(DTOUT/DT + 0.001)                                VOLAR  875
            L       = IFIX(TMAX/DTOUT + 0.001) + 1                          VOLAR  876
            N1      = IFIX(DTOUT2/DTOUT + 0.001)                            VOLAR  877
            IF(DTOUT2.LT.DTOUT) N1 = 1                                      VOLAR  878
            N2      = N1                                                    VOLAR  879
            REWIND NDATA                                                    VOLAR  880
            J       = 0                                                     VOLAR  881
            WRITE(NDATA)  L,NOUT,J                                          VOLAR  882
            CALL SETUP(INT)                                                 VOLAR  883
            WRITE(6,34005)                                                  VOLAR  884
            GO TO 402                                                       VOLAR  885
      C  *                                                                  VOLAR  886
      C  ***      PERFORM INTEGRATION FOR THIS PRINT INTERVAL.              VOLAR  887
      C  *                                                                  VOLAR  888
      1105  DO 1110 I=1,M                                                   VOLAR  889
            IF(INT.EQ.1) CALL RUNGE                                         VOLAR  890
            IF(INT.EQ.2) CALL KUTTA                                         VOLAR  891
            IF(INT.EQ.3) CALL ADAMS                                         VOLAR  892
      1110  CONTINUE                                                        VOLAR  893
      C  *                                                                  VOLAR  894
      C  ***      PRINT RESULTS FOR THIS INTERVAL.                          VOLAR  895
      C  *                                                                  VOLAR  896
      1111  N1       = N1 + 1                                               VOLAR  897
            I        = 0                                                    VOLAR  898
            IF(DTOUT2.GT.0.0.AND.N1.GE.N2) I = 1                            VOLAR  899
            CALL MISCAL(I)                                                  VOLAR  900
      IF(N1.GE.N2) N1 = 0                                                VOLAR  901
      DO 1112 I=1,NOUT                                                   VOLAR  902
      ROW(I)   = R(IO(I))                                                VOLAR  903
 1112 CONTINUE                                                           VOLAR  904
      IF(NPRNT.EQ.0) GO TO 1113                                          VOLAR  905
      WRITE(6,34001)                                                     VOLAR  906
      WRITE(6,34002)(ROW(I),I=1,NOUT)                                    VOLAR  907
 1113 WRITE(NDATA)   (ROW(I),I=1,NOUT)                                   VOLAR  908
      L        = L - 1                                                   VOLAR  909
      IF(L.GE.0.OR.(T0+0.001).LT.TMAX) GO TO 1105                        VOLAR  910
      CALL SECOND(SEC2)                                                  VOLAR  911
      SEC2     = SEC2 - SEC1                                             VOLAR  912
      WRITE(6,34013) SEC2                                                VOLAR  913
      GO TO 100                                                          VOLAR  914
C*********************************************************************** VOLAR  915
C*                                                                     * VOLAR  916
C*NOPT=28  STORE OR RETRIEVE R ARRAY VALUES ON TAPE28.                 * VOLAR  917
C*                                                                     * VOLAR  918
C*   DEFINITIONS                                                       * VOLAR  919
C*        NLIST        FILE WHERE DATA DOES OR WILL RESIDE.            * VOLAR  920
C*        K1           .GT. 0 DATA IS WRITTEN TO TAPE.                 * VOLAR  921
C*                     .LE. 0 DATA IS READ FROM TAPE.                  * VOLAR  922
C*        I,J          J TH ELEMENT I TH SEGMENT OF R ARRAY.           * VOLAR  923
C*        K,L          L TH ELEMENT K TH SEGMENT OF R ARRAY.           * VOLAR  924
C*        I,J,K,L      I/O PERFORMED FROM I,J TO K,L LOCATIONS OF R ARRAY.* VOLAR  925
C*        LABEL        VARIABLE NAMES APPEARING BETWEEN I,J AND K,L.   * VOLAR  926
C*        SCALE        SCALE FACTOR TO BE APPLIED TO DATA.             * VOLAR  927
C*                                                                     * VOLAR  928
C*   OPTION IS TERMINATED BY A BLANK CARD.                             * VOLAR  929
C*                                                                     * VOLAR  930
C*********************************************************************** VOLAR  931
30028 READ(5,31001)  K1                                                  VOLAR  932
      WRITE(6,31005) K1                                                  VOLAR  933
      REWIND 28                                                          VOLAR  934
 1900 READ(5,31008) I,J,K,L,LABEL,SCALE                                  VOLAR  935
      WRITE(6,31009)I,J,K,L,LABEL,SCALE                                  VOLAR  936
      IF(I.LE.0) GO TO 100                                               VOLAR  937
      J        = NR(I) + J                                               VOLAR  938
      L        = NR(K) + L                                               VOLAR  939
      IF(SCALE.EQ.0.0) GO TO 1902                                        VOLAR  940
      DO 1901 I=J,L                                                      VOLAR  941
      R(I)     = SCALE*R(I)                                              VOLAR  942
 1901 CONTINUE                                                           VOLAR  943
 1902 IF(K1.LE.0) GO TO 1903                                             VOLAR  944
      BUFFER OUT(28,1) (R(J),R(L))                                       VOLAR  945
      IF(UNIT(28)) 1900,100,100                                          VOLAR  946
 1903 BUFFER IN(28,1) (R(J),R(L))                                        VOLAR  947
      IF(UNIT(28)) 1900,100,100                                          VOLAR  948
C                                                                        VOLAR  949
19001 FORMAT(2A10)                                                       VOLAR  950
19002 FORMAT(/5X,2A10)                                                   VOLAR  951
23001 FORMAT(5X,5HFILE=,I2/)                                             VOLAR  952
23002 FORMAT(7F10.2)                                                     VOLAR  953
23005 FORMAT(// ///5X,7A10//)                                            VOLAR  954
23006 FORMAT(I5,5X,7A10)                                                 VOLAR  955
23007 FORMAT(5X,I5,5X,7A10)                                              VOLAR  956
23009 FORMAT(//5X5HFILE=,I2/)                                            VOLAR  957
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23011 FORMAT(5X,10F12.5)                                                   VOLAR     958
24002 FORMAT(8A10)                                                         VOLAR     959
24003 FORMAT(I5,5X,6A10)                                                   VOLAR     960
24004 FORMAT(5X,I5,5X,6A10)                                                VOLAR     961
24006 FORMAT(5X,8A10)                                                      VOLAR     962
24007 FORMAT(5X,I5,5X,5F10.4)                                              VOLAR     963
24008 FORMAT(5X,4A10,4F10.4)                                               VOLAR     964
24010 FORMAT(O6,4X,4A10)                                                   VOLAR     965
24011 FORMAT(5X,4A10,5I3,F5.3,2F7.4,O6)                                    VOLAR     966
25001 FORMAT(5X,16I5)                                                      VOLAR     967
25002 FORMAT(1H1,5X,15HSEGMENT I-ARRAY //13X,1HI,8X,5HNI(I),3X,            VOLAR     968
     1 9HLENGTH(I)   /)                                                    VOLAR     969
25006 FORMAT(4I5,6A10)                                                     VOLAR     970
25007 FORMAT(5X,4I5,6A10)                                                  VOLAR     971
25010 FORMAT(                             5X6HFILLI=,I2/5X6HFILED=,I2/5X   VOLAR     972
     1  6HFILEW=,I2/)                                                      VOLAR     973
25021 FORMAT(4A10,3A5,2X,A1,2X,2A10)                                       VOLAR     974
25022 FORMAT(5X,4A10,3A5,2X,A1,2X,2A10)                                    VOLAR     975
26002 FORMAT(8A10)                                                         VOLAR     976
26003 FORMAT(5X,8A10)                                                      VOLAR     977
27002 FORMAT(5X,67HDERIVATIVE INDICES ARE STORED INTO THE I ARRAY BEGINN VOLAR     978
     1ING AT SEGMENT,I2,8H ELEMENT,I2,1H.)                                 VOLAR     979
27003 FORMAT(5X,62HSTATE INDICES ARE STORED INTO THE I ARRAY BEGINNING A VOLAR     980
     1T SEGMENT,I2,8H ELEMENT,I2,1H.)                                      VOLAR     981
27004 FORMAT(5X,67HPDOT AND P INDICES ARE STORED INTO THE I ARRAY BEGINN VOLAR     982
     1ING AT SEGMENT,I2,8H ELEMENT,I2,1H.)                                 VOLAR     983
27005 FORMAT(5X,69HPEDOT AND PE INDICES ARE STOREQ INTO THE I ARRAY BEGI VOLAR     984
     1NNING AT SEGMENT,I2,8H ELEMENT,I2,1H.)                               VOLAR     985
27006 FORMAT(5X,69HPXDOT AND PX INDICES ARE STORED INTO THE I ARRAY BEGI VOLAR     986
     1NNING AT SEGMENT,I2,8H ELEMENT,I2, 1H.)                              VOLAR     987
31001 FORMAT(16I5)                                                         VOLAR     988
31002 FORMAT(1H1,5X,15HSEGMENT R-ARRAY //13X,1HI,8X,5HNR(I),3X,            VOLAR     989
     1 9HLENGTH(I)  /)                                                     VOLAR     990
31004 FORMAT(5X,3I10)                                                      VOLAR     991
31005 FORMAT(///5X,16I5)                                                   VOLAR     992
31008 FORMAT(4I5,5A10,    E10.3)                                           VOLAR     993
31009 FORMAT(5X,4I5,5A10,    F13.5)                                        VOLAR     994
31013 FORMAT(                             5X6HFILEI=,I2/5X6HFILED=,I2/5X   VOLAR     995
     1  6HFILEW=,I2/)                                                      VOLAR     996
31025 FORMAT(I5,5X,A4)                                                     VOLAR     997
32001 FORMAT(                                                              VOLAR     998
     1  5X5HFILE=,I2/5X7HIPUNCH=,I2/)                                      VOLAR     999
32002 FORMAT(2I5,6A10,F10.3)                                               VOLAR    1000
32003 FORMAT(2I5,6A10,F10.3)                                               VOLAR    1001
32005 FORMAT(5X, 11(2X,A10))                                               VOLAR    1002
32006 FORMAT(5X,10F12.5)                                                   VOLAR    1003
32008 FORMAT(1P7E10.3,A8,I2)                                               VOLAR    1004
33001 FORMAT(5X,45HWARNING.....WARNING.....WARNING.....WARNING.. /         VOLAR    1005
     1          5X,45H  THE USER HAS SCREWED UP.  IN NCPT=7 THE      /     VOLAR    1006
     2          5X,45H  MAXIMUM NUMBER OF OUTPUT VARIABLES IS        /     VOLAR    1007
     3          5X,45H  200 (DIMENSIONS ON IO AND OUT).  THROUGH     /     VOLAR    1008
     4          5X,45H  THE WISDOM AND FORESIGHT OF THIS ROUTINES    /     VOLAR    1009
     5          5X,45H  AUTHOR, THE USER HAS BEEN PROTECTED.  THE    /     VOLAR    1010
     6          5X,45H  ROUTINE WILL CONTINUE TO READ AS IF NO       /     VOLAR    1011
     7          5X,45H  SCREW UP HAD OCCURED, BUT NOUT WILL BE       /     VOLAR    1012
     8          5X,45H  SET TO 200 AND THE ROUTINE WILL PROCEED      /     VOLAR    1013
     9          5X,45H  AS IF ONLY THE FIRST 200 OUTPUT VARIABLES    /     VOLAR    1014
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         A       5X,45H  WERE DESIGNATED.                                /       VOLAR     1015
         P       5X,45HWARNING.....WARNING.....WARNING.....WARNING.. )           VOLAR     1016
   34001 FORMAT(//)                                                              VOLAR     1017
   34002 FORMAT(7F12.5)                                                          VOLAR     1018
   34003 FORMAT(//4X50H INPUT DESIRED INFO FOR TIME HISTORY....             /)   VOLAR     1019
   34005 FORMAT(//4X50H RESULTS OF TRIP AND THE CALL TO SETUP....           /)   VOLAR     1020
   34011 FORMAT(///5X5HNOPT=,I2,7A10//)                                          VOLAR     1021
   34012 FORMAT(I5,5X,7A10)                                                      VOLAR     1022
   34013 FORMAT(//5X,F7.3,30H CP SECONDS USED IN OPTION 21.  //)                 VOLAR     1023
         END                                                                     VOLAR     1024
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              SUPFOUTINE ADAMS                                                    ADAMS        2
        C  ****************************************************************** ADAMS        3
        C  ***                                                                    ADAMS        4
        C  ***     ROUTINE TO RERFORM SECOND CRCER ADAMS INTEGRATICN.             ADAMS        5
        C  ***                                                                    ADAMS        6
        C  ****************************************************************** ADAMS        7
        C  *                                                                      R2           2
        C  ***     RFAL VARIABLES (PROBLEM CEPENDENT).                            R2           3
        C  *                                                                      R2           4
              COMMON R(6)                                                         R2           5
        C  *                                                                      R2           6
        C  ***     INTEGRATION VARIABLES (LOCATIONS ARE PROBLEM DEPENDENT).       R2           7
        C  *                                                                      R2           8
              EQUIVALENCE (TI,R(1)),(TO,R(2)),(DT,R(3)),(DTOUT,R(4)),             R2           9
             A            (DTOUT2,R(5)),(TMAX,R(6))                               R2          10
        C  *                                                                      I            2
        C  ***     I ARRAY SEGMENT 1 - INTEGER VARIABLES.                         I            3
        C  *                                                                      I            4
              COMMON/INTEGER/ICEES,NEOU,NSTATES,NPA,NOM,NGM,NPE,NPX,NOAW,NOINIT   I            5
        C  *                                                                      I            6
        C  ***     I ARRAY SEGMENT 4 - DERIVATIVE INDICES.                        I            7
        C  *                                                                      I            8
              CGMMON/INTEGER/ INDX1(14)                                           I            9
        C  *                                                                      I           10
        C  ***     I ARRAY SEGMENT 5 - STATE INDICES.                             I           11
        C  *                                                                      I           12
              COMMON/INTEGER/ INDX2(14)                                           I           13
        C  *                                                                      I           14
        C  ***     I ARRAY SEGMENT 6 - VARIOUS INDICES.                           I           15
        C  *                                                                      I           16
              COMMON/INTEGER/ INDXPD,INDXP,INDXPED,INDXPE,INDXPXD,INDXPX          I           17
        C ****************************************************************   C I           18
        C  *                                                                      INTEG        2
        C  ***     TEMPORARY INTEGRATION STORAGE.                                 INTEG        3
        C  ***     DIMENSION = NEOU = NSTATES + NPA**2 + NPX**2 + NPE**2          INTEG        4
        C  *                                                                      INTEG        5
              COMMON/INTEG/ RI(2187),RT(2187)                                     INTEG        6
        C  *                                                                      ADAMS       11
        C  ***     COMPLETE INTEGRATION AT THIS INTEGRATION STEP.                 ADAMS       12
        C  *                                                                      ADAMS       13
              TEMP1        = 0.5*DT                                               ADAMS       14
        C  ***    STATES.                                                         ADAMS       15
              DO 10 I=1,NSTATES                                                   ADAMS       16
              R(INDX2(I))  = R(INDX2(I)) + TEMP1*(3.0*R(INDX1(I)) - RT(I))        ADAMS       17
              RT(I)        = R(INDX1(I))                                          ADAMS       18
           10 CONTINUE                                                            ADAMS       19
        C  ***    P.                                                              ADAMS       20
              NL1          = NSTATES + 1                                          ADAMS       21
              NU1          = NSTATES + NPA * NPA                                  ADAMS       22
              I1           = INDXPD                                               ADAMS       23
              I2           = INDXP                                                ADAMS       24
              DO 20 I=NL1,NU1                                                     ADAMS       25
              R(I2)        = R(I2) + TEMP1*(3.0*R(I1) - RT(I))                    ADAMS       26
              RT(I)        = R(I1)                                                ADAMS       27
              I1           = I1 + 1                                               ADAMS       28
              I2           = I2 + 1                                               ADAMS       29
           20 CONTINUE                                                            ADAMS       30
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      C  ***    PE.                                                   ADAMS    31
            NL2          = NU1 + 1                                    ADAMS    32
            NU2          = NU1 + NPE * NPE                            ADAMS    33
            I1           = INDXPED                                    ADAMS    34
            I2           = INDXPE                                     ADAMS    35
            DO 30 I=NL2,NU2                                           ADAMS    36
            R(I2)        = P(I2) + TEMP1*(3.0*R(I1) - RT(I))          ADAMS    37
            RT(I)        = R(I1)                                      ADAMS    38
            I1           = I1 + 1                                     ADAMS    39
            I2           = I2 +1                                      ADAMS    40
       30   CONTINUE                                                  ADAMS    41
      C  ***    PY.                                                   ADAMS    42
            NL3          = NU2 + 1                                    ADAMS    43
            NEQU         = NU2 + NPX * NPX                            ADAMS    44
            I1           = INDXPXD                                    ADAMS    45
            I2           = INDXPX                                     ADAMS    46
            DO 40 I=NL3,NEQU                                          ADAMS    47
            R(I2)        = R(I2) + TEMP1*(3.0*R(I1) - RT(I))          ADAMS    48
            RT(I)        = R(I1)                                      ADAMS    49
            I1           = I1 + 1                                     ADAMS    50
            I2           = I2 + 1                                     ADAMS    51
       40   CONTINUE                                                  ADAMS    52
      C  *                                                            ADAMS    53
      C  ***    GENERATE DERIVATIVES AND STATES FOR NEXT INTEGRATION STEP.  ADAMS    54
      C  *                                                            ADAMS    55
            TI           = TI + DT                                    ADAMS    56
            TO           = TO + DT                                    ADAMS    57
            CALL DEQU                                                 ADAMS    58
            CALL PROP                                                 ADAMS    59
            RFTURN                                                    ADAMS    60
            END                                                       ADAMS    61
      SUBROUTINE AIRWAKE                                                AIRWAKE       2
C******************************************************************** AIRWAKE       3
C*                                                                  * AIRWAKE       4
C*          AIRWAKE MATH MODEL - REPORT NUMBER 2-5330C/7R-3397.     * AIRWAKE       5
C*                                                                  * AIRWAKE       6
C******************************************************************** AIRWAKE       7
      DIMENSION OUT(6),AWTAB(5,5,18),XTAB(5),YTAB(5),ZTAB(3)            AIRWAKE       8
      EQUIVALENCE (VXX,AWTAB)                                           AIRWAKE       9
C  *                                                                    R             2
C  ***     R ARRAY SEGMENT 1 - INTEGRATION VARIABLES.                   R             3
C  *                                                                    R             4
      COMMON TIME,TO,DTIME,DTCUT,DTCUT2,TMAX                            R             5
C  *                                                                    R             6
C  ***     R ARRAY SEGMENT 2 - DERIVATIVES.                             R             7
C  *                                                                    R             8
      COMMON UDOT,WDOT,QDOT,TDOT,XAPPDOT,ZAPPDOT,DFRPMD,XSPDOT,         R             9
     A        ZSPDOT,TSPDOT,                                            R            10
     B        VDOT,PBDOT,RBDOT,YAPPDOT,PHIDOT,PSIDOT,YSPDOT             R            11
C  *                                                                    R            12
C  ***     R ARRAY SEGMENT 3 - STATE VARIABLES.                         R            13
C  *                                                                    R            14
      COMMON UB,WB,QB,THETA,XAPP,ZAPP,DFRPM,XSP,ZSP,THETAS,             R            15
     A         VB,PB,RB,YAPP,PHI,PSI,YSP                                R            16
C  *                                                                    R            17
C  ***     R ARRAY SEGMENT 4 - REF. VALUES FOR LOCAL LINEARIZATION.     R            18
C  *                                                                    R            19
      COMMON UO,WO,QO,THETAO,XAPPO,ZAPPO,XO,ZO,MO,UBASO,WBASO,WASDO,    R            20
     A        THETAAC,PSIAO,PHIAO,RCDO,VO,PO,RO,YAPPO,PHIO,PSIO,YO,LO,  R            21
     B        NO,VBASO                                                  R            22
      REAL    MO,LO,NO                                                  R            23
C  *                                                                    R            24
C  ***     R ARRAY SEGMENT 5 - INPUT FORCES AND MOMENTS.                R            25
C  *                                                                    R            26
      COMMON SUMFXO,SUMFZO,SUMMO,SUMFX,DFX,SUMFZ,DFZ,SUMM,DM,           R            27
     A        SUMFYO,SUMLO,SUMNO,SUMFY,DFY,SUML,DL,SUMN,DN              R            28
C  *                                                                    R            29
C  ***     R ARRAY SEGMENT 6 - GEOMETRY.                                R            30
C  *                                                                    R            31
      COMMON WEIGHT,G,IX,IY,IZ,IXZ,LM,WM,LTDM,LS,LTCS                   R            32
      REAL    G,IX,IY,IZ,IXZ,LM,LTDM,LS,LTCS                            R            33
C  *                                                                    R            34
C  ***     R ARRAY SEGMENT 7 - CONSTANTS.                               R            35
C  *                                                                    R            36
      COMMON  OMEGAU,OMEGAW,KU,KW,KFRPM,KCON,TAUENG,TAUCON,TAUD,        R            37
     1         KDEU,KDEW,KDEQ,KDET,KDEX,KDEZ,KDEN,KDEDE,KDEDT,          R            38
     2         KDTU,KDTW,KDTQ,KDTT,KDTX,KDTZ,KDTN,KDTCE,KDTDT,          R            39
     3        OMEGAV,KV,TAUA,K1,K2,KY,B1,B2,TL1,TL2                     R            40
      REAL   KU,KW,KFRPM,KCON,                                          R            41
     1       KDEU,KDEW,KDEQ,KDET,KDEX,KDEZ,KDEN,KDEDE,KDEDT,            R            42
     2       KDTU,KDTW,KDTQ,KDTT,KDTX,KDTZ,KDTN,KDTDE,KDTDT,            R            43
     3        K1,K2,KY,KV                                               R            44
C  *                                                                    R            45
C  ***     R ARRAY SEGMENT 8 - WIND, ALTITUDE, AIRSPEED AND AIRWAKE.    R            46
C  *                                                                    R            47
      COMMON ALT,VAIR,UBAS,VBAS,WBAS,ALPHA,BETA,DUM1,DUM2,V5,PSI5,X10WS, R           48
     A        Y10WS,VAMB,PSIAMB,X10WA,Y10WA,Z10WA,VWOD,PSIWOD,PSI3,PSISP, R          49
     B        PSIS,DX45,DY45,DZ45,XM,YM,ZM,PSIA,THETAA,PHIA,SIGMAVX,    R            50
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            C       SIGMAVY,SIGMAVZ,VXAW,VYAW,VZAW,UWIND,UMEAN,UR,UAW,VWIND,      R          51
            D       VMEAN,VR,VAW,WWIND,WMEAN,WR,WAW,WNSF,PSISS,PSISC,PSIST,TS1,  R          52
            E       TS2,TS3,TS4,TS5,TR1,DXM145,DXM245,DYM145,DYM245,ZGSP,        R          53
            F       ZBIASP                                                       R          54
      C  *                                                                      R          55
      C  ***    R ARRAY SEGMENT 9 - OPEN LOOP PARAMETERS.                       R          56
      C  *                                                                      R          57
            COMMON THETAC,DFPPMOL,DCONOL,DECL,GAMMAGS,RANGE,VAIPC,              R          58
            1       DAOL,DROL                                                    R          59
      C  *                                                                      R          60
      C  ***    R ARRAY SEGMENT 10 - AERO DATA.                                 R          61
      C  *                                                                      R          62
            COMMON XU,XW,XO,XFRPM,XCDN,XPDIGV,XDE,ZU,ZW,ZC,ZFRPM,ZCDN,ZPDIGV,   R          63
            A       ZDE,MU,MW,MWDOT,MO,MFRPM,MCDN,MPDIGV,MDE,                    R          64
            B         YV,YP,YR,YDA,YDR,LV,LP,LR,LDA,LDR,NV,NP,NR,                R          65
            C         NDA,NDR                                                    R          66
            REAL    MU,MW,MWDOT,MO,MFRPM,MCON,MPDIGV,MDE                        R          67
            REAL  LV,LP,LR,LDA,LDR,NV,NP,NR,NDA,NDR                             R          68
      C  *                                                                      R          69
      C  ***    R ARRAY SEGMENT 11                                              R          70
      C  *                                                                      R          71
            COMMON  PC,RCD,XAPCOM,ERRX,ERRU,         ERRZ,ERRW, ETHETA,         R          72
            1         ERY,ERPHI,ERPSI,YCOM,PHICOM,PSICOM                        R          73
      C  *                                                                      R          74
      C  ***    R ARRAY SEGMENT 12 - CONTROLS.                                  R          75
      C  *                                                                      R          76
            COMMON  DE,DT,DCON,DED,DTD,DCOND,                                   R          77
            1         DA,DR,DAP,DRP,DA1,DA2,DR1,DR2,DA1D,DA2D,DR1D,DR2D         R          78
      C  *                                                                      R          79
      C  ***    R ARRAY SEGMENT 13 - SPEED TABLE FOR AERO TABLE LOOKUPS.        R          80
      C  *                                                                      R          81
            COMMON TABV1(6)                                                     R          82
      C  *                                                                      R          83
      C  ***    R ARRAY SEGMENT 14 -  TIME TABLE FOR OPEN LOOP COMMAND TABLE L R          84
      C  *                                                                      R          85
            COMMON TABV2(10)                                                    R          86
      C  *                                                                      R          87
      C  ***    R ARRAY SEGMENT 15 - UNUSED                                     R          88
      C  *                                                                      R          89
      C  *                                                                      R          90
      C  ***    R ARRAY SEGMENT 16 - GDF RELATED STUFF                          R          91
      C  *                                                                      R          92
            COMMON SIGDAP, SIGDRP, SIGDA, SIGDR, GAINDA, GAINDR                 R          93
      C  *                                                                      R          94
      C  ***    R ARRAY SEGMENT 17 - SHIP MOTION                                R          95
      C  *                                                                      R          96
            COMMON KXS,ZETAXS,WNXS,KZS,ZETAZS,WNZS,KTS,ZETATS,WNTS,             R          97
            1       KYS,ZETAYS,WNYS,KRS,ZETARS,WNRS,KPS,ZETAPS,WNPS,TAUPRT       R          98
            REAL KXS,KZS,KTS,KYS,KRS,KPS                                        R          99
      C  *                                                                      R         100
      C  ***    R ARRAY SEGMENTS 20-23 - OPEN LOOP COMMAND TABLES.              R         101
      C  *                                                                      R         102
            COMMON TABTC(10)                                                    R         103
            COMMON TRPMOL(10)                                                   R         104
            COMMON TCONOL(10)                                                   R         105
            COMMON TDEOL(10)                                                    R         106
      C  *                                                                      R         107
      C  ***     R ARRAY SEGMENTS 24-25                                   R         108
      C  *                                                                P         109
               COMMON TARR(10)                                            R         110
               COMMON TARRDCT(10)                                         P         111
      C  *                                                                R         112
      C  ***     R ARRAY SEGMENTS 27-48 - LONGITUDINAL AERO DATA TABLES   R         113
      C  *                                                                R         114
               COMMON TXU(6)                                              P         115
               COMMON TXW(6)                                              R         116
               COMMON TXO(6)                                              R         117
               COMMON TXRPM(6)                                            R         118
               COMMON TXCON(6)                                            R         119
               COMMON TXPICV(6)                                           R         120
               COMMON TXDE(6)                                             R         121
               COMMON TZU(6)                                              R         122
               COMMON TZW(6)                                              R         123
               COMMON TZO(6)                                              R         124
               COMMON TZRPM(6)                                            R         125
               COMMON TZCON(6)                                            R         126
               COMMON TZPIGV(6)                                           R         127
               COMMON TZDE(6)                                             R         128
               COMMON TMU(6)                                              R         129
               COMMON TMW(6)                                              R         130
               COMMON TMWD(6)                                             R         131
               COMMON TMO(6)                                              R         132
               COMMON TMRPM(6)                                            R         133
               COMMON TMCON(6)                                            R         134
               COMMON TMPIGV(6)                                           R         135
               COMMON TMDE(6)                                             P         136
      C  *                                                                R         137
      C  ***     R ARRAY SEGMENTS 50-54 - COVARIANCE MATRICIES (DO NOT OVERDIME R   138
      C  *                                                                R         139
               COMMON  F(17,17),P(17,17),PDOT(17,17),GM(11,4),QM(4,4)     R         140
      C  *                                                                R         141
      C  ***     R ARRAY SEGMENTS 55-56 - STANDARD DEVIATIONS.            R         142
      C  *                                                                R         143
               COMMON SIGMA(50)                                           P         144
               COMMON SIGMAXY(50)                                         P         145
      C  *                                                                R         146
      C  ***     R ARRAY SEGMENTS 57-62 - AIRWAKE TABLES                  R         147
      C  *                                                                R         148
               COMMON VXX(5,5,3)                                          R         149
               COMMON VYY(5,5,3)                                          R         150
               COMMON VZZ(5,5,3)                                          R         151
               COMMON SVXX(5,5,3)                                         R         152
               COMMON SVYY(5,5,3)                                         R         153
               COMMON SVZZ(5,5,3)                                         R         154
      C  *                                                                R         155
      C  ***     R ARRAY SEGMENTS 63-80 - OPTIMAL CONTROLLER GAINS        R         156
      C  *                                                                P         157
               COMMON   TKDEU(6), TKDEW(6), TKDEO(6), TKDET(6), TKDEX(6), R         158
           1            TKDEZ(6), TKDEN(6), TKDEDE(6), TKDEDT(6),         R         159
           2            TKDTU(6), TKDTW(6), TKDTO(6), TKDTT(6), TKDTX(6), P         160
           3            TKDTZ(6), TKDTN(6), TKDTDE(6), TKDTDT(6)          R         161
      C  *                                                                P         162
      C  ***     R ARRAY SEGMENTS 81-106                                  R         163
      C  *                                                                R         164
      COMMON F1(6,6),G1(6,4),GAMMA(6,7),A(7,7),B(7,4),M1(1,1),M2(1,1),    R         165
     1       H(1,6),D(1,1),C(4,6),PL(4,4),W(1,1),VU(1,1),VY(1,1),         R         166
     2       VYI(1,1),S(1,1),FE(1,1),CE(1,1),PE(1,1),PED(1,1),            R         167
     3       KG(1,1),FXHAT(1,1),PXHAT(1,1),FXHATD(1,1),PX(1,1),           R         168
     4       CS(1,1)                                                      R         169
      REAL M1,M2,KG                                                       R         170
C  *                                                                      R         171
C  ***      R ARRAY SEGMENT 107 - MORE OPTIMAL CONTROLLER GAINS (NOISE REL R         172
C  *                                                                      R         173
      COMMON  DEUR, DEWR, DEVX, DEVXD, DEVZ, DEVZD,                       R         174
     1        DTUR, DTWR, DTVX, DTVXD, DTVZ, DTVZD                        R         175
C  *                                                                      R         176
C  ***      R ARRAY SEGMENTS 108-119                                      R         177
C  *                                                                      R         178
      COMMON  TDEUR(6), TDEWR(6), TDEVX(6), TDEVXD(6), TDEVZ(6),          R         179
     1         TDEVZD(6), TDTUR(6), TDTWR(6), TDTVX(6), TDTVXD(6),        R         180
     2         TDTVZ(6), TDTVZD(6)                                        R         181
C  *                                                                      R         182
C  ***      R ARRAY SEGMENTS 120-134 - LAT/DIR AERO DATA TABLES           R         183
C  *                                                                      R         184
      COMMON  TYV(6), TYP(6), TYR(6), TYDA(6), TYDR(6),                   R         185
     1          TLV(6), TLP(6), TLR(6), TLDA(6), TLDR(6),                 R         186
     2          TNV(6), TNP(6), TNR(6), TNDA(6), TNDR(6)                  R         187
C  *                                                                      R         188
C  ***      R ARRAY SEGMENTS 135-139 - LONG. TERMS REQD FOR LAT/DIR CASE  R         189
C  *                                                                      R         190
      COMMON  TABUB(10),TABWB(10),TXAPP(10),TZAPP(10),TXSP(10)            R         191
C  *                                                                      R         192
C  ***      R ARRAY SEGMENTS 140-143 - TABLES OF NONLINEAR FUNCTIONS      R         193
C  *                                                                      R         194
      COMMON TDAIN(4), TDAOUT(4), TDRIN(4),TDROUT(4)                      R         195
C  ******************************************************************** C R         196
C  *                                                                    AIRWAKE      11
C  ***      LOOKUP TABLE VALUES.                                        AIRWAKE      12
C  *                                                                    AIRWAKE      13
      DATA XTAB/   0.00 ,  37.00 ,  90.00 , 125.00 , 250.0 /            AIRWAKE      14
      DATA YTAB/ -18.75 ,   0.00 ,  18.75 ,  54.00 , 104.0 /            AIRWAKE      15
      DATA ZTAB/ -14.58 , -25.00 , -44.58 /                             AIRWAKE      16
C  *                                                                    AIRWAKE      17
C  ***      PRESET OUTPUT VARIABLES.                                    AIRWAKE      18
C  *                                                                    AIRWAKE      19
      SIGMAVX = SIGMAVY = SIGMAVZ = 0.0                                 AIRWAKE      20
      VXAW    = VYAW    = VZAW    = 0.0                                 AIRWAKE      21
      UAW     = VAW     = WAW     = 0.0                                 AIRWAKE      22
C  *                                                                    AIRWAKE      23
C  ***      SCALING RELATIONS.                                          AIRWAKE      24
C  *                                                                    AIRWAKE      25
      XD1     = 46.75/WM                                                AIRWAKE      26
      X       = XM*XD1                                                  AIRWAKE      27
      Y       = YM*XD1                                                  AIRWAKE      28
      Z       = ZM*XD1                                                  AIRWAKE      29
C  *                                                                    AIRWAKE      30
C  ***      SHAPING FUNCTION FORMULATION.                               AIRWAKE      31
C  *                                                                    AIRWAKE      32
      XD1     = Y/PSIST + TS4                                           AIRWAKE      33
      XD2     = Y/PSIST - TS4                                           AIRWAKE      34
      XD3     = 1.0                                                     AIRWAKE      35
      C   ***     CHECK FOR LIMITING CASES.                                  AIRWAKE    36
            IF(Y.LE.TS1.OR.Y.GE.TS2.OR.X.LE.-1000.0.OR.X.GE.XD1.OR.Z.LE.-100.) AIRWAKE    37
           1 XD3    =-1.0                                                    AIRWAKE    38
            FY1 = FY2 = FY3 = FX1 = FX2 = FX3 = FZ1 = XD3                    AIRWAKE    39
            IF(XD3.EQ.-1.0) GO TO 110                                        AIRWAKE    40
      C   ***     ADJUST DATA BASE.                                          AIRWAKE    41
            IF(Y.LT.-18.75.AND.X.LE.TS3)                                     AIRWAKE    42
           1 FY1     = COS(3.14159*(Y + 18.75)/(18.75 + TS1))                AIRWAKE    43
            IF(Y.LT.-18.75.AND.X.GT.TS3)                                     AIRWAKE    44
           1 FY2     = COS(3.14159*(Y + 18.75)/(18.75 - TS5 + X*PSIST))      AIRWAKE    45
            IF(Y.GT.104.0)                                                   AIRWAKE    46
           1 FY3     = COS(3.14159*(Y - 104.0)/(TS4 - 104.0))                AIRWAKE    47
            IF(X.GT.0.0.AND.Y.LT.TS5)                                        AIRWAKE    48
           1 FX1     = COS(3.14159*X/XD1)                                    AIRWAKE    49
            IF(X.GE.XD2.AND.Y.GT.TS5)                                        AIRWAKE    50
           1 FX2     = COS(1.570796*(X - XD2)/TS4)                           AIRWAKE    51
            IF(X.LT.-250.0)                                                  AIRWAKE    52
           1 FX3     = COS(-0.00418879*(X + 250.0))                          AIRWAKE    53
            IF(Z.LT.-44.58)                                                  AIRWAKE    54
           1 FZ1     = COS(-0.05668698*(Z + 44.58))                          AIRWAKE    55
            FONE        = 0.0078125*(1.0 + FY1)*(1.0 + FY2)*(1.0 + FY3)*     AIRWAKE    56
           1                        (1.0 + FX1)*(1.0 + FX2)*(1.0 + FX3)*     AIRWAKE    57
           2                        (1.0 + FZ1)                              AIRWAKE    58
            IF(FONE.EQ.0.0) GO TO 110                                        AIRWAKE    59
      C   *                                                                  AIRWAKE    60
      C   ***     TABLE LOOKUP EQUATIONS.                                    AIRWAKE    61
      C   *                                                                  AIRWAKE    62
            I     = J     = K     = 2                                        AIRWAKE    63
            XD1 = XD2 = XD3 = 1.0                                            AIRWAKE    64
      C   ***     LOCATE SECTION OF TABLE TO BE INTERPOLATED.                AIRWAKE    65
            IF(Z.GE.ZTAB(1)) GO TO 30                                        AIRWAKE    66
            DO 20 I=2,3                                                      AIRWAKE    67
            IF(Z.LT.ZTAB(I)) GO TO 20                                        AIRWAKE    68
            XD1       = (ZTAB(I) - Z)/(ZTAB(I) - ZTAB(I-1))                  AIRWAKE    69
            GO TO 30                                                         AIRWAKE    70
      20    CONTINUE                                                         AIRWAKE    71
            I         = 3                                                    AIRWAKE    72
            XD1       = 0.0                                                  AIRWAKE    73
      30    IF(Y.LE.YTAB(1)) GO TO 50                                        AIRWAKE    74
            DO 40 J=2,5                                                      AIRWAKE    75
            IF(Y.GT.YTAB(J)) GO TO 40                                        AIRWAKE    76
            XD2       = (YTAB(J) - Y)/(YTAB(J) - YTAB(J-1))                  AIRWAKE    77
            GO TO 50                                                         AIRWAKE    78
      40    CONTINUE                                                         AIRWAKE    79
            J         = 5                                                    AIRWAKE    80
            XD2       = 0.0                                                  AIRWAKE    81
      50    IF(X.GE.XTAB(1)) GO TO 70                                        AIRWAKE    82
            DO 60 K=2,5                                                      AIRWAKE    83
            IF(ABS(X).GT.XTAB(K)) GO TO 60                                   AIRWAKE    84
            XD3       = (XTAB(K) - ABS(X))/(XTAB(K) - XTAB(K-1))             AIRWAKE    85
            GO TO 70                                                         AIRWAKE    86
      60    CONTINUE                                                         AIRWAKE    87
            K         = 5                                                    AIRWAKE    88
            XD3       = 0.0                                                  AIRWAKE    89
      C   ***     INTERPOLATE.                                               AIRWAKE    90
      70    DO 100 L=1,6                                                     AIRWAKE    91
            II        = 3*(L - 1) + I                                        AIRWAKE    92
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              DO 90 M=1,2                                                       AIRWAKE     93
              JJ      = J                                                       AIRWAKE     94
              DC 80 N=1,2                                                       AIRWAKE     95
              XD5     = AWTAB(K,JJ,II) - XD3*(AWTAB(K,JJ,II) - AWTAB(K-1,JJ,II)) AIRWAKE    96
              IF(N.EQ.1) XD4 = XD5                                              AIRWAKE     97
              JJ      = JJ - 1                                                  AIRWAKE     98
      80      CCNTINUE                                                          AIRWAKE     99
              XD6     = XD4 - XD2*(XD4 - XD5)                                   AIRWAKE    100
              IF(M.EQ.1) OUT(L) = XD6                                           AIRWAKE    101
              II      = II - 1                                                  AIRWAKE    102
      90      CONTINUF                                                          AIRWAKE    103
              OUT(L)  = OUT(L) - XD1*(OUT(L) - XD6)                             AIRWAKE    104
      100     CONTINUE                                                          AIRWAKE    105
      C  *                                                                      AIRWAKE    106
      C  ***      SIGMAS.                                                       AIRWAKE    107
      C  *                                                                      AIRWAKE    108
              SIGMAVX = OUT(4)*FONE                                             AIRWAKE    109
              SIGMAVY = OUT(5)*FONE                                             AIRWAKE    110
              SIGMAVZ = OUT(6)*FONE                                             AIRWAKE    111
      C  *                                                                      AIRWAKE    112
      C  ***      INCREMENTAL AIRWAKE VELOCITIES, SHIP WIND AXIS.               AIRWAKE    113
      C  *                                                                      AIRWAKE    114
              VXAW    = (VWOD - OUT(1))*FONE                                    AIRWAKE    115
              VYAW    = OUT(2)*FONE                                             AIRWAKE    116
              VZAW    = OUT(3)*FCNE                                             AIRWAKE    117
      C  *                                                                      AIRWAKE    118
      C  ***      TRANSFOPMATION TO AIRCRAFT BODY AXIS.                         AIRWAKE    119
      C  *                                                                      AIRWAKE    120
              XD1     = COS(THETAA)                                             AIRWAKE    121
              XD2     = SIN(THETAA)                                             AIRWAKE    122
              XD3     = COS(PSIA)                                               AIRWAKE    123
              XD4     = SIN(PSIA)                                               AIRWAKE    124
              XD5     = COS(PHIA)                                               AIRWAKE    125
              XD6     = SIN(PHIA)                                               AIRWAKE    126
              UAW     = VXAW*XD1*XD3 + VYAW*XD1*XD4 - VZAW*XD2                  AIRWAKE    127
              VAW     = VXAW*(XD2*XD3*XD6 - XD4*XD5) +                          AIRWAKE    128
             1          VYAW*(XD2*XD4*XD6 + XD3*XD5) +                          AIRWAKE    129
             2          VZAW*XD1*XD6                                            AIRWAKE    130
              WAW     = VXAW*(XD2*XD3*XD5 + XD4*XD6) +                          AIRWAKE    131
             1          VYAW*(XD2*XD4*XD5 - XD3*XD6) +                          AIRWAKE    132
             2          VZAW*XD1*XD5                                            AIRWAKE    133
      110     RETURN                                                            AIRWAKE    134
              END                                                               AIRWAKE    135
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            SUBROUTINE AIRWTBL                                                AIRWTBL    2
      C ******************************************************************** AIRWTBL    3
      C ***                                                              *** AIRWTBL    4
      C ***     CALCULATE TABLES FOR AIRWAKE MATH MODEL                  *** AIRWTBL    5
      C ***                                                              *** AIRWTBL    6
      C ******************************************************************** AIRWTBL    7
      C *                                                                     R          2
      C ***     R ARRAY SEGMENT 1 - INTEGRATION VARIABLES.                    R          3
      C *                                                                     R          4
            COMMON TIME,TO,DTIME,DTOUT,DTOUT2,TMAX                            R          5
      C *                                                                     R          6
      C ***     R ARRAY SEGMENT 2 - DERIVATIVES.                              R          7
      C *                                                                     R          8
            COMMON UDOT,WDOT,QDOT,TDOT,XAPPDOT,ZAPPDOT,DFRPMD,XSPDOT,         R          9
           A       ZSPDOT,TSPDOT,                                             R         10
           B       VDOT,PBDOT,RBDOT,YAPPDOT,PHIDOT,PSIDOT,YSPDOT              R         11
      C *                                                                     R         12
      C ***     R ARRAY SEGMENT 3 - STATE VARIABLES.                          R         13
      C *                                                                     R         14
            COMMON UB,WB,QB,THETA,XAPP,ZAPP,DFRPM,XSP,ZSP,THETAS,             R         15
           A        VB,PB,RB,YAPP,PHI,PSI,YSP                                 R         16
      C *                                                                     R         17
      C ***     R ARRAY SEGMENT 4 - REF. VALUES FOR LOCAL LINEARIZATION.      R         18
      C *                                                                     R         19
            COMMON UO,WO,QO,THETAO,XAPPO,ZAPPO,XO,ZO,MO,UBASO,WBASO,WASDO,    R         20
           A       THETAAO,PSIAO,PHIAO,RCDO,VO,PO,RO,YAPPO,PHIO,PSIO,YO,LO,   R         21
           B       NO,VBASO                                                   R         22
            REAL   MO,LO,NO                                                   R         23
      C *                                                                     R         24
      C ***     R ARRAY SEGMENT 5 - INPUT FORCES AND MOMENTS.                 R         25
      C *                                                                     R         26
            COMMON SUMFXO,SUMFZO,SUMMO,SUMFX,DFX,SUMFZ,DFZ,SUMM,DM,           R         27
           A       SUMFYO,SUMLO,SUMNO,SUMFY,DFY,SUML,DL,SUMN,DN               R         28
      C *                                                                     R         29
      C ***     R ARRAY SEGMENT 6 - GEOMETRY.                                 R         30
      C *                                                                     R         31
            COMMON WEIGHT,G,IX,IY,IZ,IXZ,LM,WM,LTDM,LS,LTDS                   R         32
            REAL   G,IX,IY,IZ,IXZ,LM,LTDM,LS,LTDS                             R         33
      C *                                                                     R         34
      C ***     R ARRAY SEGMENT 7 - CONSTANTS.                                R         35
      C *                                                                     R         36
            COMMON   OMEGAU,OMEGAW,KU,KW,KFRPM,KCON,TAUENG,TAUCON,TAUD,       R         37
           1          KDEU,KDEW,KDEQ,KDET,KDEX,KDEZ,KDEN,KDEDE,KDEDT,         R         38
           2          KDTU,KDTW,KDTQ,KDTT,KCTX,KDTZ,KDTN,KDTDE,KDTDT,         R         39
           3         OMEGAV,KV,TAUA,K1,K2,KY,B1,B2,TL1,TL2                    R         40
            REAL  KU,KW,KFRPM,KCON,                                           R         41
           1      KDEU,KDEW,KDEQ,KDET,KDEX,KDEZ,KDEN,KDEDE,KDEDT,             R         42
           2      KDTU,KDTW,KDTQ,KDTT,KCTX,KDTZ,KDTN,KDTDE,KDTDT,             R         43
           3       K1,K2,KY,KV                                                R         44
      C *                                                                     R         45
      C ***     R ARRAY SEGMENT 8 - WIND, ALTITUDE, AIRSPEED AND AIRWAKE.     R         46
      C *                                                                     R         47
            COMMON ALT,VAIR,UBAS,VBAS,WBAS,ALPHA,BETA,DUM1,DUM2,V5,PSI5,X1DWS, R        48
           A       Y1DWS,VAMB,PSIAMB,X1DWA,Y1DWA,Z1DWA,VWOD,PSIWOD,PSI3,PSISP, R        49
           B       PSIS,DX45,DY45,DZ45,XM,YM,ZM,PSIA,THETAA,PHIA,SIGMAVX,     R         50
           C       SIGMAVY,SIGMAVZ,VXAW,VYAW,VZAW,UWIND,UMEAN,UR,UAW,VWIND,   R         51
           D       VMEAN,VR,VAW,WWIND,WMEAN,WR,WAW,WNSF,PSISS,PSISC,PSIST,TS1, R        52
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         F        TS2,TS3,TS4,TS5,TP1,DXM145,DXM245,DYM145,DYM245,ZGSP,          R          53
         F        ZBIASP                                                         R          54
   C  *                                                                          R          55
   C  ***      R ARRAY SEGMENT 9 - OPEN LOUP PARAMETERS.                         R          56
   C  *                                                                          R          57
         COMMON THETAC,DFRPMOL,DCDNOL,DEOL,GAMMAGS,RANGE,VAIRC,                  R          58
        1         DAOL,DPOL                                                      R          59
   C  *                                                                          R          60
   C  ***      R ARRAY SEGMENT 10 - AERO DATA.                                   R          61
   C  *                                                                          R          62
         COMMON YU,XW,XO,XFRPM,XCDN,XPDIGV,XDE,ZU,ZW,ZC,ZFRPM,ZCDN,ZPDIGV,       R          63
        A         ZDE,MU,MW,MWDOT,MQ,MFRPM,MCDN,MPDIGV,MDE,                      R          64
        B          YV,YP,YR,YDA,YDR,LV,LP,LR,LDA,LDR,NV,NP,NR,                   R          65
        C           NDA,NDR                                                      R          66
         REAL   MU,MW,MWDOT,MO,MFRPM,MCDN,MPDIGV,MDF                             R          67
         REAL  LV,LP,LR,LDA,LDR,NV,NP,NR,NDA,NDR                                 R          68
   C  *                                                                          R          69
   C  ***      R ARRAY SEGMENT 11                                                R          70
   C  *                                                                          R          71
         COMMON   RC,RCD,XAPCOM,ERRX,ERRU,          ERRZ,ERRW, ETHETA,           R          72
        1          ERY,ERPHI,ERPSI,YCOM,PHICOM,PSICOM                            R          73
   C  *                                                                          R          74
   C  ***      R ARRAY SEGMENT 12 - CONTROLS.                                    R          75
   C  *                                                                          R          76
         COMMON   DE,DT,DCON,DED,DTD,DCDND,                                      R          77
        1          DA,DR,DAP,DRP,DA1,DA2,DR1,DR2,DA1D,DA2D,DR1D,DR2D             R          78
   C  *                                                                          R          79
   C  ***      R ARRAY SEGMENT 13 - SPEED TABLE FOR AERO TABLE LOOKUPS.          R          80
   C  *                                                                          R          81
         COMMON TABV1(6)                                                         R          82
   C  *                                                                          R          83
   C  ***      R ARRAY SEGMENT 14 -  TIME TABLE FOR OPEN LOOP COMMAND TABLE L R             84
   C  *                                                                          R          85
         COMMON TABV2(10)                                                        R          86
   C  *                                                                          R          87
   C  ***      R ARRAY SEGMENT 15 - UNUSED                                       R          88
   C  *                                                                          R          89
   C  *                                                                          R          90
   C  ***      R ARRAY SEGMENT 16 - GDF RELATED STUFF                            R          91
   C  *                                                                          R          92
         COMMON SIGDAP, SIGORP, SIGDA, SIGDR, GAINDA, GAINDR                     R          93
   C  *                                                                          R          94
   C  ***      P ARRAY SEGMENT 17 - SHIP MOTION                                  P          95
   C  *                                                                          R          96
         COMMON KXS,ZETAXS,WNXS,KZS,ZETAZS,WNZS,KTS,ZETATS,WNTS,                 R          97
        1         KYS,ZETAYS,WNYS,KRS,ZETARS,WNRS,KPS,ZETAPS,WNPS,TAUPRT         R          98
         REAL KXS,KZS,KTS,KYS,KRS,KPS                                            R          99
   C  *                                                                          R         100
   C  ***      R ARRAY SEGMENTS 20-23 - OPEN LOOP COMMAND TABLES.                R         101
   C  *                                                                          R         102
         COMMON TABTC(10)                                                        R         103
         COMMON TRPMOL(10)                                                       R         104
         COMMON TCDNOL(10)                                                       R         105
         COMMON TCEOL(10)                                                        R         106
   C  *                                                                          R         107
   C  ***      R ARRAY SEGMENTS 24-25                                            R         108
   C  *   1    [illegible](1,1),[illegible](1,1),[illegible],VH(1,1),VY(1,1),    R         109
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      COMMON TARR(10)                                                    R     110
      COMMON TARRDOT(10)                                                 R     111
C *                                                                      R     112
C ***     R ARRAY SEGMENTS 27-48 - LONGITUDINAL AERO DATA TABLES         R     113
C *                                                                      R     114
      COMMON TXU(6)                                                      R     115
      COMMON TXW(6)                                                      R     116
      COMMON TXO(6)                                                      R     117
      COMMON TXRPM(6)                                                    R     118
      COMMON TXCON(6)                                                    R     119
      COMMON TXPIGV(6)                                                   R     120
      COMMON TXDE(6)                                                     R     121
      COMMON TZU(6)                                                      R     122
      COMMON TZW(6)                                                      R     123
      COMMON TZO(6)                                                      R     124
      COMMON TZRPM(6)                                                    R     125
      COMMON TZCON(6)                                                    R     126
      COMMON TZPIGV(6)                                                   R     127
      COMMON TZDE(6)                                                     R     128
      COMMON TMU(6)                                                      R     129
      COMMON TMW(6)                                                      R     130
      COMMON TMWD(6)                                                     R     131
      COMMON TMO(6)                                                      R     132
      COMMON TMRPM(6)                                                    R     133
      COMMON TMCON(6)                                                    R     134
      COMMON TMPIGV(6)                                                   R     135
      COMMON TMDE(6)                                                     R     136
C *                                                                      R     137
C ***     R ARRAY SEGMENTS 50-54 - COVARIANCE MATRICIES (DO NOT OVERDIME R     138
C *                                                                      R     139
      COMMON   F(17,17),P(17,17),PDOT(17,17),GM(11,4),QM(4,4)            R     140
C *                                                                      R     141
C ***     R ARRAY SEGMENTS 55-56 - STANDARD DEVIATIONS.                  R     142
C *                                                                      R     143
      COMMON SIGMA(50)                                                   R     144
      COMMON SIGMAXY(50)                                                 R     145
C *                                                                      R     146
C ***     R ARRAY SEGMENTS 57-62 - AIRWAKE TABLES                        R     147
C *                                                                      R     148
      COMMON VXX(5,5,3)                                                  R     149
      COMMON VYY(5,5,3)                                                  R     150
      COMMON VZZ(5,5,3)                                                  R     151
      COMMON SVXX(5,5,3)                                                 R     152
      COMMON SVYY(5,5,3)                                                 R     153
      COMMON SVZZ(5,5,3)                                                 R     154
C *                                                                      R     155
C ***     R ARRAY SEGMENTS 63-80 - OPTIMAL CONTROLLER GAINS              R     156
C *                                                                      R     157
      COMMON   TKDEU(6), TKDEW(6), TKDEQ(6), TKDET(6), TKDEX(6),         R     158
     1         TKDEZ(6), TKDEN(6), TKDEDE(6), TKDEDT(6),                 R     159
     2         TKDTU(6), TKDTW(6), TKDTQ(6), TKDTT(6), TKDTX(6),         R     160
     3         TKDTZ(6), TKDTN(6), TKDTDE(6), TKDTDT(6)                  R     161
C *                                                                      R     162
C ***     R ARRAY SEGMENTS 81-106                                        R     163
C *                                                                      R     164
      COMMON F1(6,6),G1(6,4),GAMMA(6,7),A(7,7),B(7,4),M1(1,1),M2(1,1),   R     165
     1       H(1,1),D(1,1),C(4,6),RL(4,4),W(1,1),VU(1,1),VY(1,1), [illegible]     166
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          2       VYI(1,1),S(1,1),FE(1,1),OE(1,1),PF(1,1),PED(1,1),            R      167
          3       KG(1,1),FXHAT(1,1),PXHAT(1,1),PXHATD(1,1),PX(1,1),           R      168
          4       CS(1,1)                                                      R      169
          REAL M1,M2,KG                                                        R      170
      C  *                                                                     R      171
      C  ***     R ARRAY SEGMENT 107 - MORE OPTIMAL CONTROLLER GAINS (NOISE REL R      172
      C  *                                                                     R      173
          COMMON  DEUR, DEWR, DEVX, DEVXD, DEVZ, DEVZD,                        R      174
          1       DTUR, DTWR, DTVX, DTVXD, DTVZ, DTVZD                         R      175
      C  *                                                                     R      176
      C  ***     R ARRAY SEGMENTS 108-119                                      R      177
      C  *                                                                     R      178
          COMMON  TDEUR(6), TDEWR(6), TDEVX(6), TDEVXD(6), TDEVZ(6),           R      179
          1       TDEVZD(6),  TDTUR(6), TDTWR(6), TDTVX(6), TDTVXD(6),         R      180
          2       TDTVZ(6), TDTVZD(6)                                          R      181
      C *                                                                      R      182
      C ***      R ARRAY SEGMENTS 120-134 - LAT/DIR AERO DATA TABLES           R      183
      C *                                                                      R      184
          COMMON  TYV(6), TYP(6), TYR(6), TYDA(6), TYDR(6),                    R      185
          1       TLV(6), TLP(6), TLR(Q), TLDA(6), TLDR(6),                    R      186
          2       TNV(6), TNP(6), TNR(6), TNDA(6), TNDR(6)                     R      187
      C *                                                                      R      188
      C ***      R ARRAY SEGMENTS 135-139 - LONG. TERMS REQD FOR LAT/DIR CASE  R      189
      C *                                                                      R      190
          COMMON  TABUR(10),TABWB(10),TXAPP(10),TZAPP(10),TXSP(10)             R      191
      C  *                                                                     R      192
      C  ***     R ARRAY SEGMENTS 140-143 - TABLES OF NONLINEAR FUNCTIONS      R      193
      C  *                                                                     R      194
          COMMON TDAIN(4), TDAOUT(4), TDRIN(4),TDROUT(4)                       R      195
      C  ****************************************************************** C R      196
      C                                                                    AIRWTBL    9
          DIMENSION TAB1(5,5,108) , TAB2(5,5,18), TABWOD(3)                AIRWTBL   10
      C                                                                    AIRWTBL   11
          DIMENSION TABIA(5,5,3) , TABIB(5,5,3) , TABIC(5,5,3) ,           AIRWTBL   12
         A          TABID(5,5,3) , TABIE(5,5,3) , TABIF(5,5,3)             AIRWTBL   13
      C                                                                    AIRWTBL   14
          DIMENSION TABIIA(5,5,3) , TABIIB(5,5,3) , TABIIC(5,5,3) ,        AIRWTBL   15
         A          TABIID(5,5,3) , TABIIE(5,5,3) , TABIIF(5,5,3)          AIRWTBL   16
      C                                                                    AIRWTBL   17
          DIMENSION TABIIIA(5,5,3) , TABIIIB(5,5,3) , TABIIIC(5,5,3) ,     AIRWTBL   18
         A          TABIIID(5,5,3) , TABIIIE(5,5,3) , TABIIIF(5,5,3)       AIRWTBL   19
      C                                                                    AIRWTBL   20
          DIMENSION TABIVA(5,5,3) , TABIVB(5,5,3) , TABIVC(5,5,3) ,        AIRWTBL   21
         A          TABIVD(5,5,3) , TABIVE(5,5,3) , TABIVF(5,5,3)          AIRWTBL   22
      C                                                                    AIRWTBL   23
          DIMENSION TABVA(5,5,3) , TABVB(5,5,3) , TABVC(5,5,3) ,           AIRWTBL   24
         A          TABVD(5,5,3) , TABVE(5,5,3) , TABVF(5,5,3)             AIRWTBL   25
      C                                                                    AIRWTBL   26
          DIMENSION TABVIA(5,5,3) , TABVIB(5,5,3) , TABVIC(5,5,3) ,        AIRWTBL   27
         A          TABVID(5,5,3) , TABVIE(5,5,3) , TABVIF(5,5,3)          AIRWTBL   28
      C                                                                    AIRWTBL   29
          EQUIVALENCE (TABIA   , TAB1(1,1,  1)) , (TABIB   , TAB1(1,1,  4)), AIRWTBL   30
         A            (TABIC   , TAB1(1,1,  7)) , (TABID   , TAB1(1,1, 10)), AIRWTBL   31
         B            (TABIE   , TAB1(1,1, 13)) , (TABIF   , TAB1(1,1, 16)), AIRWTBL   32
         C            (TABIIA  , TAB1(1,1, 19)) , (TABIIB  , TAB1(1,1, 22)), AIRWTBL   33
         D            (TABIIC  , TAB1(1,1, 25)) , (TABIID  , TAB1(1,1, 28)), AIRWTBL   34
         F            (TABIIE  , TAB1(1,1, 31)) , (TABIIF  , TAB1(1,1, 34)), AIRWTBL   35
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     F           (TABIIIA , TAB1(1,1, 37)) , (TABIIIB , TAB1(1,1, 40)), AIRWTBL   36
     G           (TABIIIC , TAB1(1,1, 43)) , (TABIIID , TAB1(1,1, 46)), AIRWTBL   37
     H           (TABIIIE , TAB1(1,1, 49)) , (TABIIIF , TAB1(1,1, 52)), AIRWTBL   38
     I           (TABIVA  , TAB1(1,1, 55)) , (TABIVB  , TAB1(1,1, 58)), AIRWTBL   39
     J           (TABIVC  , TAB1(1,1, 61)) , (TABIVD  , TAB1(1,1, 64)), AIRWTBL   40
     K           (TABIVE  , TAB1(1,1, 67)) , (TABIVF  , TAB1(1,1, 70)), AIRWTBL   41
     L           (TABVA   , TAB1(1,1, 73)) , (TABVB   , TAB1(1,1, 76)), AIRWTBL   42
     M           (TABVC   , TAB1(1,1, 79)) , (TABVD   , TAB1(1,1, 82)), AIRWTBL   43
     N           (TABVE   , TAB1(1,1, 85)) , (TABVF   , TAB1(1,1, 88)), AIRWTBL   44
     O           (TABVIA  , TAB1(1,1, 91)) , (TABVIB  , TAB1(1,1, 94)), AIRWTBL   45
     P           (TABVIC  , TAB1(1,1, 97)) , (TABVID  , TAB1(1,1,100)), AIRWTBL   46
     Q           (TABVIE  , TAB1(1,1,103)) , (TABVIF  , TAB1(1,1,106))  AIRWTBL   47
C                                                                       AIRWTBL   48
      EQUIVALENCE (VXX,TAB2)                                            AIRWTBL   49
C   *                                                                   AIRWTBL   50
C   ***     TABLE 1A. VX AT VSS = 20 KT AND SIS = 30 DEG.               AIRWTBL   51
C   *                                                                   AIRWTBL   52
      DATA TAB1A/                                                       AIRWTBL   53
C                                                                       AIRWTBL   54
C   Y          X =     0.00    37.00 . 90.00    125.0    250.0    ZTAB = -14 AIRWTBL   55
C                                                                       AIRWTBL   56
  -18.75               28.46 , 15.68 , 17.25 , 17.19 , 13.70 ,          AIRWTBL   57
    0.0                 3.10 , 12.34 , 19.64 , 19.53 , 16.14 ,          AIRWTBL   58
   18.75               24.62 , 16.13 , 21.17 , 22.99 , 19.63 ,          AIRWTBL   59
   54.0                18.66 , 16.14 , 18.43 , 21.71 , 28.63 ,          AIRWTBL   60
  104.0                13.52 , 22.08 , 27.99 , 29.34 , 29.97 ,          AIRWTBL   61
C                                                                       AIRWTBL   62
C   Y          X =     0.00    37.00   90.00    125.0    250.0    ZTAB = -25 AIRWTBL   63
C                                                                       AIRWTBL   64
  -18.75               29.12 , 27.11 , 16.19 , 18.03 , 18.60 ,          AIRWTBL   65
    0.0                19.07 , 19.86 , 21.42 , 21.28 , 15.52 ,          AIRWTBL   66
   18.75               29.67 , 21.91 , 26.80 , 26.00 , 18.39 ,          AIRWTBL   67
   54.0                22.70 , 20.73 , 25.02 , 25.41 , 29.99 ,          AIRWTBL   68
  104.0                17.59 , 23.37 , 27.80 , 28.77 , 29.21 ,          AIRWTBL   69
C                                                                       AIRWTBL   70
C   Y          X =     0.00    37.00   90.00    125.0    250.0    ZTAB = -44 AIRWTBL   71
C                                                                       AIRWTBL   72
  -18.75               31.68 , 31.56 , 28.79 , 23.84 , 23.89 ,          AIRWTBL   73
    0.0                31.81 , 32.08 , 27.65 , 23.35 , 20.52 ,          AIRWTBL   74
   18.75               31.77 , 31.55 , 29.03 , 27.40 , 14.65 ,          AIRWTBL   75
   54.0                30.29 , 30.86 , 30.73 , 31.09 , 30.67 ,          AIRWTBL   76
  104.0                26.22 , 27.64 , 29.63 , 29.40 , 29.09 /          AIRWTBL   77
C   *                                                                   AIRWTBL   78
C   ***     TABLE IB. VX AT VSS = 20 KT AND SIS = 50 DEG.               AIRWTBL   79
C   *                                                                   AIRWTBL   80
      DATA TAB1B/                                                       AIRWTBL   81
C                                                                       AIRWTBL   82
C   Y          X =     0.00    37.00   90.00    125.0    250.0    ZTAB = -14 AIRWTBL   83
C                                                                       AIRWTBL   84
  -18.75               29.89 , 24.68 , 12.64 , 10.29 , 10.92 ,          AIRWTBL   85
    0.0                10.85 ,  3.73 ,  6.71 ,  8.01 , 11.30 ,          AIRWTBL   86
   18.75               -1.66 ,  4.45 ,  7.28 ,  6.32 ,  9.92 ,          AIRWTBL   87
   54.0                 7.54 ,  6.66 ,  6.86 ,  2.72 , 10.10 ,          AIRWTBL   88
  104.0                 3.81 ,  5.06 ,  6.68 ,  6.48 , 19.56 ,          AIRWTBL   89
C                                                                       AIRWTBL   90
C   Y          X =     0.00    37.00   90.00    125.0    250.0    ZTAB = -25 AIRWTBL   91
C   [illegible]        [illegible] , [illegible] , [illegible] , [illegible] , [illegible] ,          AIRWTBL   92
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     -18.75              30.68 , 26.80 , 19.48 , 14.14 , 19.39 ,                 AIRWTBL   93
       0.0               23.90 ,  9.42 , 11.86 ,  9.19 , 15.18 ,                 AIRWTBL   94
      18.75               7.47 , 10.88 , 12.24 ,  9.71 , 13.08 ,                 AIRWTBL   95
      54.0               28.40 , 19.54 , 15.27 , 12.05 , 17.36 ,                 AIRWTBL   96
     104.0               16.12 , 14.08 , 11.10 , 10.21 , 16.89 ,                 AIRWTBL   97
C                                                                                 AIRWTBL   98
C  Y           X =    0.00    37.00    90.00    125.0    250.0    ZTAB = -44 AIRWTBL   99
C                                                                                 AIRWTBL  100
     -18.75              33.36 , 34.62 , 31.50 , 27.16 , 22.43 ,                 AIRWTBL  101
       0.0               33.49 , 31.27 , 21.88 , 20.71 , 17.95 ,                 AIRWTBL  102
      18.75              34.22 , 29.48 , 20.99 , 20.95 , 12.34 ,                 AIRWTBL  103
      54.0               36.01 , 35.78 , 32.39 , 30.50 , 24.34 ,                 AIRWTBL  104
     104.0                8.07 , 16.89 , 23.95 , 23.73 , 28.99 /                 AIRWTBL  105
C  *                                                                              AIRWTBL  106
C  ***    TABLE IC. VX AT VSS = 35 KT AND SIS = 30 DEG.                          AIRWTBL  107
C  *                                                                              AIRWTBL  108
      DATA TABIC/                                                                 AIRWTBL  109
C                                                                                 AIRWTBL  110
C  Y           X =    0.00    37.00    90.00    125.0    250.0    ZTAB = -14 AIRWTBL  111
C                                                                                 AIRWTBL  112
     -18.75              48.91 , 25.18 ; 28.91 , 28.69 , 28.15 ,                 AIRWTBL  113
       0.0                9.08 , 23.43 , 31.62 , 31.60 , 31.56 ,                 AIRWTBL  114
      18.75              38.91 , 34.75 , 34.44 , 35.42 , 39.84 ,                 AIRWTBL  115
      54.0               31.35 , 29.94 , 30.48 , 37.30 , 51.71 ,                 AIRWTBL  116
     104.0               24.54 , 32.14 , 45.88 , 51.11 , 53.68 ,                 AIRWTBL  117
C                                                                                 AIRWTBL  118
C  Y           X =    0.00    37.00    90.00    125.0    250.0    ZTAB = -25 AIRWTBL  119
C                                                                                 AIRWTBL  120
     -18.75              51.67 , 48.67 , 29.34 , 30.90 , 30.72 ,                 AIRWTBL  121
       0.0               31.62 , 35.13 , 32.07 , 30.55 , 31.15 ,                 AIRWTBL  122
      18.75              52.77 , 46.36 , 43.06 , 45.71 , 39.39 ,                 AIRWTBL  123
      54.0               40.17 , 38.47 , 39.14 , 45.49 , 55.78 ,                 AIRWTBL  124
     104.0               31.42 , 39.33 , 46.56 , 50.91 , 52.85 ,                 AIRWTBL  125
C                                                                                 AIRWTBL  126
C  Y           X =    0.00    37.00    90.00    125.0    250.0    ZTAB = -44 AIRWTBL  127
C                                                                                 AIRWTBL  128
     -18.75              59.61 , 59.29 , 54.97 , 45.56 , 46.16 ,                 AIRWTBL  129
       0.0               59.61 , 59.66 , 55.08 , 44.86 , 37.93 ,                 AIRWTBL  130
      18.75              58.53 , 58.68 , 56.29 , 54.85 , 27.39 ,                 AIRWTBL  131
      54.0               58.18 , 57.34 , 57.06 , 58.34 , 37.06 ,                 AIRWTBL  132
     104.0               45.92 , 49.34 , 51.94 , 53.73 , 45.59 /                 AIRWTBL  133
C  *                                                                              AIRWTBL  134
C  ***    TABLE ID. VX AT VSS = 35 KT AND SIS = 50 DEG.                          AIRWTBL  135
C  *                                                                              AIRWTBL  136
      DATA TABID/                                                                 AIRWTBL  137
C                                                                                 AIRWTBL  138
C  Y           X =    0.00    37.00    90.00    125.0    250.0    ZTAB = -14 AIRWTBL  139
C                                                                                 AIRWTBL  140
     -18.75              54.85 , 48.77 , 25.67 , 23.25 , 22.69 ,                 AIRWTBL  141
       0.0               24.42 ,  7.12 , 13.05 , 14.17 , 19.99 ,                 AIRWTBL  142
      18.75              -5.40 ,  2.97 , 12.64 , 11.81 , 15.93 ,                 AIRWTBL  143
      54.0               16.30 , 12.25 , 11.29 ,  7.00 , 16.64 ,                 AIRWTBL  144
     104.0               10.78 , 10.41 ,  8.16 , 15.68 , 31.59 ,                 AIRWTBL  145
C                                                                                 AIRWTBL  146
C  Y           X =    0.00    37.00    90.00    125.0    250.0    ZTAB = -25 AIRWTBL  147
C                                                                                 AIRWTBL  148
     -18.75              56.32 ; 56.52 ; 37.52 ; 34.10 ; 30.83 ;                 AIRWTBL  149
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      0.0          46.67 , 23.07 , 20.92 , 18.69 , 24.76 ,                  AIRWTBL   150
     18.75         10.75 , 11.55 , 22.53 , 18.32 , 20.50 ,                  AIRWTBL   151
     54.0          52.43 , 34.79 , 24.41 , 20.20 , 25.11 ,                  AIRWTBL   152
    104.0          23.67 , 25.59 , 17.43 , 22.29 , 33.68 ,                  AIRWTBL   153
C                                                                           AIRWTBL   154
C   Y          X =   0.00    37.00    90.00   125.0   250.0     ZTAB = -44  AIRWTBL   155
C                                                                           AIRWTBL   156
    -18.75         61.99 , 65.63 , 61.99 , 55.57 , 33.10 ,                  AIRWTBL   157
      0.0          61.21 , 60.72 , 47.69 , 40.10 , 27.52 ,                  AIRWTBL   158
     18.75         62.41 , 51.42 , 38.42 , 32.00 , 16.34 ,                  AIRWTBL   159
     54.0          67.22 , 68.20 , 54.67 , 48.81 , 13.46 ,                  AIRWTBL   160
    104.0          16.26 , 29.72 , 37.37 , 33.75 , 22.15 /                  AIRWTBL   161
C   *                                                                       AIRWTBL   162
C   ***     TABLE IF. VX AT VSS = 45 KT AND SIS = 30 DEG.                   AIRWTBL   163
C   *                                                                       AIRWTBL   164
         DATA TABIE/                                                        AIRWTBL   165
C                                                                           AIRWTBL   166
C   Y          X =   0.00    37.00    90.00   125.0   250.0     ZTAB = -14  AIRWTBL   167
C                                                                           AIRWTBL   168
    -18.75         65.36 , 33.66 , 35.41 , 34.61 , 32.46 ,                  AIRWTBL   169
      0.0          12.27 , 31.36 , 38.95 , 33.99 , 33.55 ,                  AIRWTBL   170
     18.75         45.97 , 41.83 , 40.11 , 39.03 , 42.87 ,                  AIRWTBL   171
     54.0          40.22 , 40.03 , 38.33 , 43.60 , 67.00 ,                  AIRWTBL   172
    104.0          32.56 , 44.81 , 57.46 , 64.04 , 69.07 ,                  AIRWTBL   173
C                                                                           AIRWTBL   174
C   Y          X =   0.00    37.00    90.00   125.0   250.0     ZTAB = -25  AIRWTBL   175
C                                                                           AIRWTBL   176
    -18.75         72.02 , 66.73 , 37.43 , 37.71 , 38.85 ,                  AIRWTBL   177
      0.0          43.95 , 45.81 , 40.88 , 39.28 , 36.41 ,                  AIRWTBL   178
     18.75         65.01 , 53.49 , 50.36 , 48.92 , 45.46 ,                  AIRWTBL   179
     54.0          41.44 , 46.77 , 46.89 , 56.65 , 70.43 ,                  AIRWTBL   180
    104.0          40.64 , 50.32 , 59.79 , 63.50 , 68.02 ,                  AIRWTBL   181
C                                                                           AIRWTBL   182
C   Y          X =   0.00    37.00    90.00   125.0   250.0     ZTAB = -44  AIRWTBL   183
C                                                                           AIRWTBL   184
    -18.75         75.23 , 75.44 , 70.54 , 57.54 , 49.01 ,                  AIRWTBL   185
      0.0          74.93 , 76.11 , 71.34 , 58.65 , 49.12 ,                  AIRWTBL   186
     18.75         73.69 , 74.71 , 72.11 , 69.90 , 52.98 ,                  AIRWTBL   187
     54.0          73.06 , 70.38 , 70.67 , 74.38 , 74.42 ,                  AIRWTBL   188
    104.0          57.45 , 61.85 , 65.49 , 65.56 , 69.06 /                  AIRWTBL   189
C   *                                                                       AIRWTBL   190
C   ***     TABLE IF. VX AT VSS = 45 KT AND SIS = 50 DEG.                   AIRWTBL   191
C   *                                                                       AIRWTBL   192
         DATA TABIF/                                                        AIRWTBL   193
C                                                                           AIRWTBL   194
C   Y          X =   0.00    37.00    90.00   125.0   250.0     ZTAB = -14  AIRWTBL   195
C                                                                           AIRWTBL   196
    -18.75         75.52 , 71.69 , 39.59 , 29.08 , 26.57 ,                  AIRWTBL   197
      0.0          39.33 , 11.80 , 13.82 , 20.84 , 22.95 ,                  AIRWTBL   198
     18.75         -9.08 ,  3.87 , 10.68 , 17.09 , 20.65 ,                  AIRWTBL   199
     54.0          19.08 , 14.04 , 14.66 , 12.93 , 21.55 ,                  AIRWTBL   200
    104.0          11.57 ,  9.25 ,  6.33 , 14.21 , 38.44 ,                  AIRWTBL   201
C                                                                           AIRWTBL   202
C   Y          X =   0.00    37.00    90.00   125.0   250.0     ZTAB = -25  AIRWTBL   203
C                                                                           AIRWTBL   204
    -18.75         77.68 , 80.95 , 56.43 , 41.51 , 36.76 ,                  AIRWTBL   205
      0.0          65.99 , 32.81 , 26.38 , 30.50 , 30.51 ,                  AIRWTBL   206
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         18.75              10.49 , 17.44 , 20.76 , 27.28 , 26.38 ,                   AIRWTBL   207
          54.0              63.90 , 35.23 , 26.17 , 24.18 , 27.88 ,                   AIRWTBL   208
         104.0              37.50 , 24.73 , 18.87 , 21.71 , 40.96 ,                   AIRWTBL   209
      C                                                                               AIRWTBL   210
      C  Y          X =      0.00   37.00   90.00   125.0   250.0      ZTAB = -44 AIRWTBL   211
      C                                                                               AIRWTBL   212
        -18.75              79.97 , 82.79 , 77.67 , 69.34 , 57.35 ,                   AIRWTBL   213
           0.0              78.49 , 75.16 , 56.57 , 53.56 , 51.35 ,                   AIRWTBL   214
         18.75              79.76 , 56.22 , 41.59 , 40.91 , 43.69 ,                   AIRWTBL   215
          54.0              85.52 , 86.19 , 71.83 , 61.04 , 55.71 ,                   AIRWTBL   216
         104.0              17.65 , 35.79 , 47.24 , 46.83 , 54.48 /                   AIRWTBL   217
      C  *                                                                            AIRWTBL   218
      C  ***     TABLE IIA. VY AT VSS = 20 KT AND SIS = 30 DEG.                       AIRWTBL   219
      C  *                                                                            AIRWTBL   220
            DATA TABIIA/                                                              AIRWTBL   221
      C                                                                               AIRWTBL   222
      C  Y          X =      0.00   37.00   90.00   125.0   250.0      ZTAB = -14 AIRWTBL   223
      C                                                                               AIRWTBL   224
        -18.75              -0.41 ,  0.17 , -5.56 , -2.65 , -0.02 ,                   AIRWTBL   225
           0.0               3.75 , -5.10 , -4.32 , -2.04 , -1.18 ,                   AIRWTBL   226
         18.75              -1.96 , -4.10 , -1.57 , -0.98 , -1.13 ,                   AIRWTBL   227
          54.0              -2.35 , -0.59 ,  0.27 , -0.08 , -2.01 ,                   AIRWTBL   228
         104.0               0.85 , -1.92 , -3.71 , -4.16 , -2.56 ,                   AIRWTBL   229
      C                                                                               AIRWTBL   230
      C  Y          X =      0.00   37.00   90.00   125.0   250.0      ZTAB = -25 AIRWTBL   231
      C                                                                               AIRWTBL   232
        -18.75               2.84 ,  4.65 ,  0.48 ,  0.99 ,  3.20 ,                   AIRWTBL   233
           0.0               6.45 ,  4.52 , -0.33 , -0.99 ,  0.52 ,                   AIRWTBL   234
         18.75               3.80 ,  1.08 ,  1.31 ,  1.50 ,  1.70 ,                   AIRWTBL   235
          54.0               0.72 ,  1.57 ,  2.88 ,  1.00 ,  0.65 ,                   AIRWTBL   236
         104.0               0.90 , -3.41 , -2.41 , -2.92 , -2.38 ,                   AIRWTBL   237
      C                                                                               AIRWTBL   238
      C  Y          X =      0.00   37.00   90.00   125.0   250.0      ZTAB = -44 AIRWTBL   239
      C                                                                               AIRWTBL   240
        -18.75               3.07 ,  4.36 ,  6.84 ,  5.38 ,  5.10 ,                   AIRWTBL   241
           0.0               1.65 ,  2.47 ,  4.95 ,  3.87 ,  3.33 ,                   AIRWTBL   242
         18.75               4.11 ,  3.88 ,  8.26 ,  6.94 , -0.39 ,                   AIRWTBL   243
          94.0               3.67 ,  4.24 ,  5.61 ,  5.35 ,  3.66 ,                   AIRWTBL   244
         104.0               3.09 ,  2.80 ,  2.02 ,  1.03 ,  0.91 /                   AIRWTBL   245
      C  *                                                                            AIRWTBL   246
      C  ***     TABLE IIIA. VZ AT VSS = 20 KT AND SIS = 30 DEG.                      AIRWTBL   247
      C  *                                                                            AIRWTBL   248
      C  *                                                                            AIRWTBL   249
      C  ***     TABLE IIB. VY AT VSS = 20 KT AND SIS = 50 DEG.                       AIRWTBL   250
      C  *                                                                            AIRWTBL   251
            DATA TABIIB/                                                              AIRWTBL   252
      C                                                                               AIRWTBL   253
      C  Y          X =      0.00   37.00   90.00   125.0   250.0      ZTAB = -14 AIRWTBL   254
      C                                                                               AIRWTBL   255
        -18.75              -1.43 , -4.90 , -3.30 , -0.05 ,  2.46 ,                   AIRWTBL   256
           0.0               3.89 , -5.44 , -3.33 ,  0.06 ,  3.35 ,                   AIRWTBL   257
         18.75              -7.14 , -6.36 , -2.64 , -0.26 ,  0.80 ,                   AIRWTBL   258
          54.0              -3.00 , -1.63 ,  0.91 ,  4.96 ,  1.46 ,                   AIRWTBL   259
         104.0               2.39 ,  3.77 ,  2.17 , -0.19 , -3.18 ,                   AIRWTBL   260
      C                                                                               AIRWTBL   261
      C  Y          X =      0.00   37.00   90.00   125.0   250.0      ZTAB = -25 AIRWTBL   262
      C                                                                               AIRWTBL   263
         [illegible]        [illegible] , [illegible] , [illegible] , [illegible] ,  7.91 ,
     -18.75          1.34 , -2.35 , -1.13 , -0.02 ,  6.19 ,          AIRWTBL  264
       0.0           5.65 , -2.05 , -1.84 , -0.86 ,  4.59 ,          AIRWTBL  265
      18.75          3.35 , -3.37 , -0.53 ,  1.39 ,  3.39 ,          AIRWTBL  266
      54.0           1.80 ,  0.75 ,  3.76 ,  5.71 ,  1.65 ,          AIRWTBL  267
     104.0           7.33 ,  6.44 ,  3.16 ,  0.79 , -2.29 ,          AIRWTBL  268
C                                                                    AIRWTBL  269
C   Y         X =    0.00   37.00   90.00   125.0   250.0  ZTAB = -44 AIRWTBL  270
C                                                                    AIRWTBL  271
     -18.75          0.49 ,  0.37 ,  3.34 ,  2.25 ,  4.80 ,          AIRWTBL  272
       0.0          -1.68 , -0.26 ,  0.05 , -0.53 ,  2.05 ,          AIRWTBL  273
      18.75          2.68 ,  1.39 ,  0.52 , -0.19 , -0.69 ,          AIRWTBL  274
      54.0           2.08 ,  1.94 ,  2.00 ,  2.32 ,  1.80 ,          AIRWTBL  275
     104.0           3.24 ,  6.99 ,  5.31 ,  3.00 ,  3.09 /          AIRWTBL  276
C   *                                                                AIRWTBL  277
C   ***      TABLE IIC. VY AT VSS = 35 KT AND SIS = 30 DEG.          AIRWTBL  278
C   *                                                                AIRWTBL  279
      DATA TABIIC/                                                   AIRWTBL  280
C                                                                    AIRWTBL  281
C   Y         X =    0.00   37.00   90.00   125.0   250.0  ZTAB = -14 AIRWTBL  282
C                                                                    AIRWTBL  283
     -18.75         -0.13 ,  0.21 , -9.44 , -6.94 , -0.25 ,          AIRWTBL  264
       0.0           6.50 , -8.52 , -7.84 , -3.88 , -1.87 ,          AIRWTBL  285
      18.75         -5.74 , -6.78 , -3.96 , -1.57 , -3.02 ,          AIRWTBL  286
      54.0          -4.45 , -0.35 ,  1.34 , -3.06 , -2.13 ,          AIRWTBL  287
     104.0           2.25 , -1.19 , -7.95 ,-10.04 , -5.56 ,          AIRWTBL  288
C                                                                    AIRWTBL  289
C   Y         X =    0.00   37.00   90.00   125.0   250.0  ZTAB = -25 AIRWTBL  290
C                                                                    AIRWTBL  291
     -18.75          6.61 , 10.81 ,  2.21 , -0.61 ,  3.92 ,          AIRWTBL  292
       0.0          12.80 , 11.08 ,  2.19 ,  0.08 ,  1.65 ,          AIRWTBL  293
      18.75          9.07 , 13.60 ,  5.27 ,  4.42 ,  1.61 ,          AIRWTBL  294
      54.0           2.20 ,  3.91 ,  6.87 ,  2.34 , -0.09 ,          AIRWTBL  295
     104.0           3.16 , -2.66 , -4.48 , -5.90 , -4.96 ,          AIRWTBL  296
C                                                                    AIRWTBL  297
C   Y         X =    0.00   37.00   90.00   125.0   250.0  ZTAB = -44 AIRWTBL  298
C                                                                    AIRWTBL  299
     -18.75          4.55 ,  7.29 , 13.31 , 10.40 , 12.32 ,          AIRWTBL  300
       0.0           3.58 ,  5.71 , 11.17 ,  7.77 ,  7.35 ,          AIRWTBL  301
      18.75         10.87 ,  9.93 , 15.92 , 15.55 ,  4.18 ,          AIRWTBL  302
      54.0          11.78 , 12.12 , 13.84 , 10.73 ,  5.86 ,          AIRWTBL  303
     104.0           7.53 ,  5.85 ,  6.81 ,  3.40 ,  3.62 /          AIRWTBL  304
C   *                                                                AIRWTBL  305
C   ***      TABLE IID. VY AT VSS = 35 KT AND SIS = 50 DEG.          AIRWTBL  306
C   *                                                                AIRWTBL  307
      DATA TABIID/                                                   AIRWTBL  308
C                                                                    AIRWTBL  309
C   Y         X =    0.00   37.00   90.00   125.0   250.0  ZTAB = -14 AIRWTBL  310
C                                                                    AIRWTBL  311
     -18.75         -3.66 , -7.13 , -3.73 ,  2.09 ,  3.41 ,          AIRWTBL  312
       0.0           3.74 , -4.95 , -3.97 ,  1.31 ,  2.38 ,          AIRWTBL  313
      18.75         -9.64 ,-10.33 , -7.90 , -0.16 , -0.55 ,          AIRWTBL  314
      54.0           0.93 , -4.11 , -1.64 ,  5.05 , -2.81 ,          AIRWTBL  315
     104.0           6.03 , 10.44 ,  3.57 ,  0.99 , -6.71 ,          AIRWTBL  316
C                                                                    AIRWTBL  317
C   Y         X =    0.00   37.00   90.00   125.0   250.0  ZTAB = -25 AIRWTBL  318
C                                                                    AIRWTBL  319
     -18.75          0.87 , -2.99 ,  0.70 ,  3.88 ,  7.51 ,          AIRWTBL  320
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               0.0            1.47 , -1.48 , -2.50 ,  1.56 ,  4.98 ,                  AIRWTBL   321
              18.75           3.81 , -3.47 , -4.46 ,  3.35 ,  3.63 ,                  AIRWTBL   322
              54.0           -1.44 , -0.48 ,  8.26 ,  9.36 ,  2.20 ,                  AIRWTBL   323
             104.0            9.49 ,  9.96 ,  4.95 ,  3.22 , -4.05 ,                  AIRWTBL   324
      C                                                                               AIRWTBL   325
      C  Y           X =      0.00    37.00   90.00   125.0   250.0    ZTAB = -44 AIRWTBL   326
      C                                                                               AIRWTBL   327
             -18.75           1.57 ,  2.52 ,  5.48 ,  4.68 ,  1.79 ,                  AIRWTBL   328
               0.0           -1.34 ,  1.27 ,  1.95 ,  2.05 , -3.71 ,                  AIRWTBL   329
              18.75           8.86 ,  7.28 ,  4.24 ,  1.13 , -3.79 ,                  AIRWTBL   330
              54.0            4.57 ,  5.31 ,  6.58 ,  8.41 , -5.12 ,                  AIRWTBL   331
             104.0            6.75 , 10.10 ,  9.62 ,  8.44 , -0.46 /                  AIRWTBL   332
      C  *                                                                            AIRWTBL   333
      C  ***     TABLE IIE. VY AT VSS = 45 KT AND SIS = 30 DEG.                       AIRWTBL   334
      C  *                                                                            AIRWTBL   335
            DATA TABIIF/                                                              AIRWTBL   336
      C                                                                               AIRWTBL   337
      C  Y           X =      0.00    37.00   90.00   125.0   250.0    ZTAB = -14 AIRWTBL   338
      C                                                                               AIRWTBL   339
             -18.75          -3.97 , -1.94 ,-12.87 , -5.98 ,  1.19 ,                  AIRWTBL   340
               0.0           12.83 ,-16.82 , -9.13 , -2.18 , -0.06 ,                  AIRWTBL   341
              18.75         -10.93 ,-12.36 , -3.26 , -1.71 , -3.27 ,                  AIRWTBL   342
              54.0          -10.14 , -1.21 ,  1.86 ,  0.67 , -2.67 ,                  AIRWTBL   343
             104.0            4.89 , -4.28 ,-12.30 ,-13.19 , -6.90 ,                  AIRWTBL   344
      C                                                                               AIRWTBL   345
      C  Y           X =      0.00    37.00   90.00   125.0   250.0    ZTAB = -25 AIRWTBL   346
      C                                                                               AIRWTBL   347
             -18.75           6.86 , 11.91 ,  2.52 ,  0.13 ,  8.44 ,                  AIRWTBL   348
               0.0           21.23 , 16.36 ,  1.53 ,  0.11 ,  3.69 ,                  AIRWTBL   349
              18.75          10.03 ,  2.27 ,  4.28 ,  7.09 ,  2.42 ,                  AIRWTBL   350
              54.0            2.80 ,  6.50 ,  8.80 ,  5.15 ,  0.24 ,                  AIRWTBL   351
             104.0            4.67 , -1.73 , -6.05 , -6.88 , -7.30 ,                  AIRWTBL   352
      C                                                                               AIRWTBL   353
      C  Y           X =      0.00    37.00   90.00   125.0   250.0    ZTAB = -44 AIRWTBL   354
      C                                                                               AIRWTBL   355
             -18.75           6.23 ,  8.70 , 15.06 , 14.61 , 15.17 ,                  AIRWTBL   356
               0.0            3.98 ,  6.67 , 13.81 ,  9.86 ,  9.33 ,                  AIRWTBL   357
              18.75          13.66 , 12.94 , 21.41 , 19.74 , 10.03 ,                  AIRWTBL   358
              54.0           15.87 , 15.27 , 19.13 , 14.82 ,  6.45 ,                  AIRWTBL   359
             104.0            9.20 ,  7.40 ,  8.66 ,  4.28 , -1.66 /                  AIRWTBL   360
      C  *                                                                            AIRWTBL   361
      C  ***     TABLE IIF. VY AT VSS = 45 KT AND SIS = 50 DEG.                       AIRWTBL   362
      C  *                                                                            AIRWTBL   363
            DATA TABIIF/                                                              AIRWTBL   364
      C                                                                               AIRWTBL   365
      C  Y           X =      0.00    37.00   90.00   125.0   250.0    ZTAB = -14 AIRWTBL   366
      C                                                                               AIRWTBL   367
             -18.75          -4.95 ,-11.73 ,  0.73 , -2.89 ,  3.65 ,                  AIRWTBL   368
               0.0            5.18 , -7.20 , -0.07 , -0.23 ,  2.48 ,                  AIRWTBL   369
              18.75         -15.63 ,-15.71 , -4.81 ,  0.60 ,  0.83 ,                  AIRWTBL   370
              54.0           -1.15 , -8.26 ,  1.33 ,  3.27 , -1.58 ,                  AIRWTBL   371
             104.0            5.52 , 12.74 ,  7.59 ,  3.84 , -9.16 ,                  AIRWTBL   372
      C                                                                               AIRWTBL   373
      C  Y           X =      0.00    37.00   90.00   125.0   250.0    ZTAB = -25 AIRWTBL   374
      C                                                                               AIRWTBL   375
             -18.75          -0.79 , -3.53 , -0.71 ,  1.23 ,  9.90 ,                  AIRWTBL   376
               0.0           -5.20 , -1.30 , -0.93 , -0.07 ,  6.83 ,                  AIRWTBL   377
      18.75              1.90 , -7.26 , -3.00 ,  4.42 ,  5.70 ,                AIRWTBL  378
      54.0              -0.87 ,  3.10 ,  9.11 ,  9.00 ,  1.11 ,                AIRWTBL  379
     104.0              16.61 , 13.55 ,  8.07 ,  5.33 , -5.58 ,                AIRWTBL  380
C                                                                              AIRWTBL  381
C  Y          X =        0.00   37.00   90.00   125.0   250.0     ZTAB = -44 AIRWTBL  382
C                                                                              AIRWTBL  383
     -18.75              1.80 ,  2.92 ,  6.04 ,  8.00 , 14.94 ,                AIRWTBL  384
       0.0              -5.24 ,  2.19 ,  4.77 ,  3.07 ,  8.66 ,                AIRWTBL  385
      18.75              8.19 , 11.74 ,  3.59 ,  2.46 ,  7.81 ,                AIRWTBL  386
      54.0               4.24 ,  4.32 ,  9.80 , 10.13 ,  7.60 ,                AIRWTBL  387
     104.0               6.36 , 10.59 , 14.86 ,  8.28 ,  6.28 /                AIRWTBL  388
      DATA TABIIIA/                                                            AIRWTBL  369
C                                                                              AIRWTBL  390
C  Y          X =        0.00   37.00   90.00   125.0   250.0     ZTAB = -14 AIRWTBL  391
C                                                                              AIRWTBL  392
     -18.75             -7.73 , -3.15 , -3.57 , -3.85 ,  0.45 ,                AIRWTBL  393
       0.0              -1.26 , -3.66 , -3.26 , -2.48 ,  1.13 ,                AIRWTBL  394
      18.75              2.24 , -1.10 , -1.40 ,  0.19 ,  2.49 ,                AIRWTBL  395
      54.0              -2.41 , -1.35 ,  2.20 ,  3.83 ,  5.69 ,                AIRWTBL  396
     104.0               6.85 ,  6.31 ,  8.00 ,  6.47 ,  3.23 ,                AIRWTBL  397
C                                                                              AIRWTBL  398
C  Y          X =        0.00   37.00   90.00   125.0   250.0     ZTAB = -25 AIRWTBL  399
C                                                                              AIRWTBL  400
     -18.75             -6.44 , -7.41 , -5.49 , -5.46 , -0.93 ,                AIRWTBL  401
       0.0              -3.76 , -3.17 , -2.57 , -1.32 ,  2.34 ,                AIRWTBL  402
      18.75             -0.14 ,  0.76 ,  1.23 ,  3.37 ,  4.00 ,                AIRWTBL  403
      54.0              -0.93 ,-0.002 ,  3.00 ,  3.50 ,  5.86 ,                AIRWTBL  404
     104.0               9.79 , 12.37 , 10.17 ,  8.09 ,  4.35 ,                AIRWTBL  405
C                                                                              AIRWTBL  406
C  Y          X =        0.00   37.00   90.00   125.0   250.0     ZTAB = -44 AIRWTBL  407
C                                                                              AIRWTBL  408
     -18.75             -7.13 , -6.72 , -7.59 , -5.40 , -2.37 ,                AIRWTBL  409
       0.0              -7.22 , -3.84 , -4.71 , -3.06 , -0.19 ,                AIRWTBL  410
      18.75             -3.91 , -1.05 , -0.70 ,  5.26 , 10.79 ,                AIRWTBL  411
      54.0              -3.86 , -2.35 , -0.50 ,  0.81 ,  3.52 ,                AIRWTBL  412
     104.0               3.81 ,  5.54 ,  5.17 ,  4.40 ,  1.52 /                AIRWTBL  413
C *                                                                            AIRWTBL  414
C  ***   TABLE IIIB. VZ AT VSS = 20 KT AND SIS = 50 DEG.                       AIRWTBL  415
C *                                                                            AIRWTBL  416
      DATA TABIIIB/                                                            AIRWTBL  417
C                                                                              AIRWTBL  418
C  Y          X =        0.00   37.00   90.00   125.0   250.0     ZTAB = -14 AIRWTBL  419
C                                                                              AIRWTBL  420
     -18.75             -7.99 , -0.95 , -0.81 , -3.09 , -0.18 ,                AIRWTBL  421
       0.0              -3.98 , -2.17 , -5.13 , -4.28 ,  1.78 ,                AIRWTBL  422
      18.75             -1.60 , -2.40 , -3.31 , -3.40 ,  2.15 ,                AIRWTBL  423
      54.0               0.34 , -3.24 , -3.12 ,  0.13 ,  2.37 ,                AIRWTBL  424
     104.0              -5.96 , -2.26 ,  1.41 ,  2.22 ,  4.15 ,                AIRWTBL  425
C                                                                              AIRWTBL  426
C  Y          X =        0.00   37.00   90.00   125.0   250.0     ZTAB = -25 AIRWTBL  427
C                                                                              AIRWTBL  428
     -18.75             -7.08 , -4.15 , -2.05 , -3.62 ,  0.20 ,                AIRWTBL  429
       0.0              -7.44 , -3.20 , -3.94 , -3.25 ,  1.16 ,                AIRWTBL  430
      18.75             -0.90 , -2.35 , -1.55 , -2.22 ,  2.36 ,                AIRWTBL  431
      54.0              -1.11 , -1.92 , -1.41 ,  0.46 ,  4.79 ,                AIRWTBL  432
     104.0              -6.56 , -0.41 ,  2.54 ,  4.93 ,  7.78 ,                AIRWTBL  433
C                                                                              AIRWTBL  434
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      C  Y          X =      0.00    37.00    90.00    125.0    250.0      ZTAB = -44 AIRWTBL   435
      C                                                                             AIRWTBL   436
      -18.75              -7.79 , -7.18 , -6.26 , -3.67 , -1.90 ,                   AIRWTBL   437
        0.0               -8.54 , -5.58 , -2.35 , -0.80 , -0.10 ,                   AIRWTBL   438
       18.75              -6.10 , -0.12 , -0.60 ,  4.35 ,  8.32 ,                   AIRWTBL   439
       54.0               -5.34 , -3.92 , -2.20 ,  0.07 ,  4.48 ,                   AIRWTBL   440
      104.0               -4.39 , -2.62 ,  1.33 ,  1.39 ,  4.17 /                   AIRWTBL   441
      C  *                                                                          AIRWTBL   442
      C  ***    TABLE IIIC. VZ AT VSS = 35 KT AND SIS = 30 DEG.                     AIRWTBL   443
      C  *                                                                          AIRWTBL   444
            DATA TABIIIC/                                                           AIRWTBL   445
      C                                                                             AIRWTBL   446
      C  Y          X =      0.00    37.00    90.00    125.0    250.0      ZTAB = -14 AIRWTBL   447
      C                                                                             AIRWTBL   448
      -18.75             -20.55 , -6.90 , -9.55 , -8.56 ,  0.99 ,                   AIRWTBL   449
        0.0               -3.96 , -4.32 , -7.82 , -3.80 ,  4.66 ,                   AIRWTBL   450
       18.75               7.73 , -0.19 , -0.85 ,  1.52 ,  8.42 ,                   AIRWTBL   451
       54.0               -3.31 , -0.48 ,  4.55 , 10.41 , 12.51 ,                   AIRWTBL   452
      104.0               13.32 , 15.00 , 20.61 , 15.67 ,  7.18 ,                   AIRWTBL   453
      C                                                                             AIRWTBL   454
      C  Y          X =      0.00    37.00    90.00    125.0    250.0      ZTAB = -25 AIRWTBL   455
      C                                                                             AIRWTBL   456
      -18.75             -14.69 ,-16.63 ,-11.50 , -8.37 , -0.33 ,                   AIRWTBL   457
        0.0               -6.59 , -3.82 , -6.24 , -5.46 ,  5.24 ,                   AIRWTBL   458
       18.75              -1.03 ,  0.43 ,  3.06 ,  4.66 , 11.22 ,                   AIRWTBL   459
       54.0               -4.65 ,  0.38 ,  6.12 ,  8.72 , 12.00 ,                   AIRWTBL   460
      104.0               15.72 , 20.68 , 22.37 , 17.10 ,  7.96 ,                   AIRWTBL   461
      C                                                                             AIRWTBL   462
      C  Y          X =      0.00    37.00    90.00    125.0    250.0      ZTAB = -44 AIRWTBL   463
      C                                                                             AIRWTBL   464
      -18.75             -13.01 ,-12.41 ,-14.71 ,-10.58 , -2.76 ,                   AIRWTBL   465
        0.0              -13.06 , -8.93 , -7.62 , -5.73 ,  0.01 ,                   AIRWTBL   466
       18.75              -6.91 , -4.07 ,  0.95 ,  3.37 ,  8.53 ,                   AIRWTBL   467
       54.0               -8.24 , -4.15 , -0.70 ,  3.25 ,  7.31 ,                   AIRWTBL   468
      104.0                9.74 , 11.65 , 10.93 ,  9.72 ,  8.09 /                   AIRWTBL   469
      C  *                                                                          AIRWTBL   470
      C  ***    TABLE IIID. VZ AT VSS = 35 KT AND SIS = 50 DEG.                     AIRWTBL   471
      C  *                                                                          AIRWTBL   472
            DATA TABIIID/                                                           AIRWTBL   473
      C                                                                             AIRWTBL   474
      C  Y          X =      0.00    37.00    90.00    125.0    250.0      ZTAB = -14 AIRWTBL   475
      C                                                                             AIRWTBL   476
      -18.75             -16.44 , -4.29 , -0.87 , -3.49 ,  1.42 ,                   AIRWTBL   477
        0.0               -8.85 , -0.92 , -7.29 , -6.59 ,  5.62 ,                   AIRWTBL   478
       18.75              -4.27 , -4.46 , -5.11 , -2.91 ,  5.21 ,                   AIRWTBL   479
       54.0               -0.10 , -4.43 , -5.82 , -1.96 ,  5.71 ,                   AIRWTBL   480
      104.0              -12.31 , -4.81 ,  3.46 ,  8.96 , 11.97 ,                   AIRWTBL   481
      C                                                                             AIRWTBL   482
      C  Y          X =      0.00    37.00    90.00    125.0    250.0      ZTAB = -25 AIRWTBL   483
      C                                                                             AIRWTBL   484
      -18.75             -14.70 , -9.35 , -5.61 , -3.60 , -0.44 ,                   AIRWTBL   485
        0.0              -16.39 , -5.63 , -5.55 , -3.26 ,  4.65 ,                   AIRWTBL   486
       18.75              -3.12 , -3.41 , -3.72 , -2.04 ,  4.84 ,                   AIRWTBL   487
       54.0               -2.44 , -2.64 , -4.71 , -0.33 ,  7.73 ,                   AIRWTBL   488
      104.0              -12.96 , -2.12 ,  6.39 , 10.86 , 14.09 ,                   AIRWTBL   489
      C                                                                             AIRWTBL   490
      C  Y          X =      0.00    37.00    90.00    125.0    250.0      ZTAB = -44 AIRWTBL   491
      C                                                                    AIRWTBL  492
      -18.75           -15.59 ,-12.78 ,-10.27 , -6.63 ,  6.11 ,            AIRWTBL  493
        0.0            -16.61 ,-12.92 , -3.89 , -2.26 ,  6.99 ,            AIRWTBL  494
       18.75           -13.05 , -4.31 ,  1.94 ,  1.75 , 10.16 ,            AIRWTBL  495
        54.0           -11.49 , -7.63 , -5.62 , -1.33 ,  2.05 ,            AIRWTBL  496
       104.0           -10.52 , -2.74 ,  0.52 ,  3.35 ,  3.19 /            AIRWTBL  497
      C  *                                                                 AIRWTBL  498
      C  ***    TABLE IIIE. VZ AT VSS = 45 KT AND SIS = 30 DEG.            AIRWTBL  499
      C  *                                                                 AIRWTBL  500
             DATA TABIIIE/                                                 AIRWTBL  501
      C                                                                    AIRWTBL  502
      C  Y            X =    0.00   37.00   90.00   125.0   250.0   ZTAB = -14 AIRWTBL  503
      C                                                                    AIRWTBL  504
      -18.75           -31.11 , -7.50 ,-12.57 ,-12.04 ,  1.70 ,            AIRWTBL  505
        0.0             -7.25 , -7.35 ,-10.22 , -7.05 ,  6.11 ,            AIRWTBL  506
       18.75             7.88 , -3.06 , -3.44 ,  1.54 , 11.27 ,            AIRWTBL  507
        54.0            -7.99 , -1.01 ,  8.31 , 12.76 , 19.52 ,            AIRWTBL  508
       104.0            18.29 , 23.33 , 26.66 , 23.45 ,  8.29 ,            AIRWTBL  509
      C                                                                    AIRWTBL  510
      C  Y            X =    0.00   37.00   90.00   125.0   250.0   ZTAB = -25 AIRWTBL  511
      C                                                                    AIRWTBL  512
      -18.75           -19.44 ,-24.72 ,-13.77 ,-14.05 , -0.02 ,            AIRWTBL  513
        0.0            -16.64 , -7.08 , -7.74 , -7.02 ,  5.76 ,            AIRWTBL  514
       18.75            -0.62 ,  3.89 ,  1.88 ,  1.70 , 13.79 ,            AIRWTBL  515
        54.0            -3.81 , -1.33 ,  6.59 , 11.90 , 16.00 ,            AIRWTBL  516
       104.0            19.67 , 28.69 , 28.56 , 24.13 , 10.01 ,            AIRWTBL  517
      C                                                                    AIRWTBL  518
      C  Y            X =    0.00   37.00   90.00   125.0   250.0   ZTAB = -44 AIRWTBL  519
      C                                                                    AIRWTBL  520
      -18.75           -15.59 ,-16.00 ,-18.86 ,-13.57 , -5.32 ,            AIRWTBL  521
        0.0            -15.49 ,-11.40 ,-11.19 , -7.62 ,  3.39 ,            AIRWTBL  522
       18.75            -8.35 , -4.41 ,  0.91 ,  3.71 , 10.99 ,            AIRWTBL  523
        54.0           -10.30 , -4.00 ,  0.54 ,  4.16 , 10.18 ,            AIRWTBL  524
       104.0            12.07 , 14.93 , 15.77 , 12.17 ,  4.63 /            AIRWTBL  525
      C  *                                                                 AIRWTBL  526
      C  ***    TABLE IIIF. VZ AT VSS = 45 KT AND SIS = 50 DEG.            AIRWTBL  527
      C  *                                                                 AIRWTBL  528
             DATA TABIIIF/                                                 AIRWTBL  529
      C                                                                    AIRWTBL  530
      C  Y            X =    0.00   37.00   90.00   125.0   250.0   ZTAB = -14 AIRWTBL  531
      C                                                                    AIRWTBL  532
      -18.75           -24.54 , -1.09 , -0.05 , -2.22 , -0.77 ,            AIRWTBL  533
        0.0            -10.45 ,  1.20 , -5.97 , -6.13 ,  2.19 ,            AIRWTBL  534
       18.75            -4.25 , -5.27 , -6.56 , -4.14 ,  5.81 ,            AIRWTBL  535
        54.0            -0.23 , -6.15 , -6.40 , -3.32 ,  7.16 ,            AIRWTBL  536
       104.0           -12.95 , -2.81 ,  2.42 ,  6.74 , 12.87 ,            AIRWTBL  537
      C                                                                    AIRWTBL  538
      C  Y            X =    0.00   37.00   90.00   125.0   250.0   ZTAB = -25 AIRWTBL  539
      C                                                                    AIRWTBL  540
      -18.75           -21.37 ,-13.51 , -3.29 , -7.69 , -2.59 ,            AIRWTBL  541
        0.0            -22.99 , -7.15 , -5.21 , -3.86 ,  3.17 ,            AIRWTBL  542
       18.75            -5.65 , -6.19 , -4.56 , -3.03 ,  5.13 ,            AIRWTBL  543
        54.0            -3.77 , -8.66 , -4.91 , -0.99 ,  9.51 ,            AIRWTBL  544
       104.0           -13.57 , -1.05 ,  5.56 ,  9.98 , 18.29 ,            AIRWTBL  545
      C                                                                    AIRWTBL  546
      C  Y            X =    0.00   37.00   90.00   125.0   250.0   ZTAB = -44 AIRWTBL  547
      C                                                                    AIRWTBL  548
      -18.75            -17.25 ,-16.49 ,-15.28 , -8.78 , -2.43 ,                  AIRWTBL   549
        0.0             -23.82 ,-15.95 , -4.85 , -3.78 ,  0.61 ,                  AIRWTBL   550
       18.75            -18.37 , -6.60 ,  3.38 ,  4.07 , 11.51 ,                  AIRWTBL   551
       54.0             -14.39 , -9.76 , -5.00 ,  1.12 , 10.49 ,                  AIRWTBL   552
      104.0              -9.70 , -2.54 ,  2.86 ,  6.68 , 10.82 /                  AIRWTBL   553
C  *                                                                              AIRWTBL   554
C  ***    TABLE IVA. SIGMA VX AT VSS = 20 KT AND SIS = 30 DEG.                    AIRWTBL   555
C  *                                                                              AIRWTBL   556
      DATA TABIVA/                                                                AIRWTBL   557
C                                                                                 AIRWTBL   558
C  Y           X =    0.00    37.00    90.00    125.0    250.0      ZTAB = -14   AIRWTBL   559
C                                                                                 AIRWTBL   560
      -18.75           1.62 ,  8.19 ,  4.53 ,  4.18 ,  3.23 ,                     AIRWTBL   561
        0.0            6.51 ,  5.30 ,  5.12 ,  4.94 ,  3.72 ,                     AIRWTBL   562
       18.75           4.65 ,  4.74 ,  5.00 ,  4.85 ,  5.07 ,                     AIRWTBL   563
       54.0            5.23 ,  4.47 ,  4.98 ,  5.39 ,  2.69 ,                     AIRWTBL   564
      104.0            5.51 ,  4.47 ,  3.12 ,  2.05 ,  1.29 ,                     AIRWTBL   565
C                                                                                 AIRWTBL   566
C  Y           X =    0.00    37.00    90.00    125.0    250.0      ZTAB = -25   AIRWTBL   567
C                                                                                 AIRWTBL   568
      -18.75           1.05 ,  4.31 ,  6.37 ,  5.79 ,  4.06 ,                     AIRWTBL   569
        0.0            6.53 ,  6.75 ,  5.92 ,  5.23 ,  3.43 ,                     AIRWTBL   570
       18.75           1.76 ,  6.09 ,  4.38 ,  4.33 ,  5.09 ,                     AIRWTBL   571
       54.0            5.03 ,  4.23 ,  3.78 ,  3.56 ,  1.97 ,                     AIRWTBL   572
      104.0            6.35 ,  5.71 ,  3.64 ,  2.10 ,  1.18 ,                     AIRWTBL   573
C                                                                                 AIRWTBL   574
C  Y           X =    0.00    37.00    90.00    125.0    250.0      ZTAB = -44   AIRWTBL   575
C                                                                                 AIRWTBL   576
      -18.75           0.80 ,  1.09 ,  5.23 ,  6.47 ,  3.46 ,                     AIRWTBL   577
        0.0            0.88 ,  1.33 ,  4.49 ,  6.28 ,  4.10 ,                     AIRWTBL   578
       18.75           0.88 ,  1.03 ,  3.62 ,  4.86 ,  8.44 ,                     AIRWTBL   579
       54.0            4.20 ,  2.79 ,  2.80 ,  2.48 ,  1.58 ,                     AIRWTBL   580
      104.0            5.49 ,  3.60 ,  1.82 ,  1.73 ,  0.88 /                     AIRWTBL   581
C  *                                                                              AIRWTBL   582
C  ***    TABLE IVB. SIGMA VX AT VSS = 20 KT AND SIS = 50 DEG.                    AIRWTBL   583
C  *                                                                              AIRWTBL   584
      DATA TABIVB/                                                                AIRWTBL   585
C                                                                                 AIRWTBL   586
C  Y           X =    0.00    37.00    90.00    125.0    250.0      ZTAB = -14   AIRWTBL   587
C                                                                                 AIRWTBL   588
      -18.75           1.65 ,  8.74 ,  9.53 ,  7.99 ,  7.16 ,                     AIRWTBL   589
        0.0           11.01 ,  6.90 ,  6.38 ,  6.28 ,  6.18 ,                     AIRWTBL   590
       18.75           5.52 ,  5.83 ,  5.50 ,  5.59 ,  6.97 ,                     AIRWTBL   591
       54.0            7.13 ,  4.93 ,  8.04 ,  6.29 ,  7.30 ,                     AIRWTBL   592
      104.0            6.27 ,  5.86 ,  6.17 ,  7.43 ,  6.50 ,                     AIRWTBL   593
C                                                                                 AIRWTBL   594
C  Y           X =    0.00    37.00    90.00    125.0    250.0      ZTAB = -25   AIRWTBL   595
C                                                                                 AIRWTBL   596
      -18.75           1.10 ,  6.23 , 10.08 ,  9.20 ,  6.86 ,                     AIRWTBL   597
        0.0           8.83 ,  8.66 ,  8.47 ,  6.94 ,  7.39 ,                      AIRWTBL   598
       18.75           8.55 ,  7.48 ,  8.05 ,  6.58 ,  7.15 ,                     AIRWTBL   599
       54.0            4.65 ,  7.99 ,  9.07 ,  7.47 ,  6.72 ,                     AIRWTBL   600
      104.0            8.62 ,  7.73 ,  6.92 ,  7.63 ,  6.20 ,                     AIRWTBL   601
C                                                                                 AIRWTBL   602
C  Y           X =    0.00    37.00    90.00    125.0    250.0      ZTAB = -44   AIRWTBL   603
C                                                                                 AIRWTBL   604
      -18.75           0.78 ,  1.77 ,  5.08 ,  6.72 ,  7.84 ,                     AIRWTBL   605
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        0.0           0.91 ,  5.95 ,  8.00 ,  8.97 ,  8.63 ,                   AIRWTBL   606
       18.75          1.28 ,  6.53 ,  8.47 ,  9.80 ,  6.82 ,                   AIRWTBL   607
       54.0           0.71 ,  2.15 ,  6.00 ,  5.57 ,  6.59 ,                   AIRWTBL   608
      104.0           6.45 ,  7.07 ,  5.54 ,  6.16 ,  4.14 /                   AIRWTBL   609
C  *                                                                           AIRWTBL   610
C  ***   TABLE IVC. SIGMA VX AT VSS = 35 KT AND SIS = 30 DFG.                  AIRWTBL   611
C  *                                                                           AIRWTBL   612
      DATA TABIVC/                                                             AIRWTBL   613
C                                                                              AIRWTBL   614
C  Y           X =    0.00    37.00   90.00   125.0   250.0      ZTAB = -14    AIRWTBL   615
C                                                                              AIRWTBL   616
     -18.75           3.74 , 13.05 ,  6.12 ,  4.99 ,  4.35 ,                   AIRWTBL   617
        0.0          13.33 , 10.08 ,  7.78 ,  7.40 ,  5.29 ,                   AIRWTBL   618
       18.75          9.95 ,  8.33 ,  7.50 ,  7.16 ,  7.64 ,                   AIRWTBL   619
       54.0           7.73 ,  7.29 ,  7.73 ,  6.73 ,  5.89 ,                   AIRWTBL   620
      104.0           7.13 ,  6.27 ,  6.42 ,  5.44 ,  3.18 ,                   AIRWTBL   621
C                                                                              AIRWTBL   622
C  Y           X =    0.00    37.00   90.00   125.0   250.0      ZTAB = -25    AIRWTBL   623
C                                                                              AIRWTBL   624
     -18.75           2.09 ,  8.95 , 10.07 ,  6.71 ,  4.89 ,                   AIRWTBL   625
        0.0          11.39 , 10.10 ,  8.62 ,  7.05 ,  5.85 ,                   AIRWTBL   626
       18.75          5.16 ,  9.28 ,  9.22 ,  8.43 ,  7.16 ,                   AIRWTBL   627
       54.0           7.35 ,  7.43 ,  7.87 ,  7.59 ,  2.69 ,                   AIRWTBL   628
      104.0           8.55 ,  7.84 ,  7.29 ,  5.75 ,  3.60 ,                   AIRWTBL   629
C                                                                              AIRWTBL   630
C  Y           X =    0.00    37.00   90.00   125.0   250.0      ZTAB = -44    AIRWTBL   631
C                                                                              AIRWTBL   632
     -18.75           0.89 ,  1.72 ,  6.91 , 10.03 , 12.61 ,                   AIRWTBL   633
        0.0           1.17 ,  2.10 ,  7.35 , 10.04 , 13.17 ,                   AIRWTBL   634
       18.75          1.24 ,  1.91 ,  5.59 ,  7.38 , 13.70 ,                   AIRWTBL   635
       54.0           6.02 ,  6.20 ,  5.43 ,  3.98 , 12.41 ,                   AIRWTBL   636
      104.0           9.58 ,  7.81 ,  5.44 ,  3.90 ,  9.43 /                   AIRWTBL   637
C  *                                                                           AIRWTBL   638
C  ***   TABLE IVD. SIGMA VX AT VSS = 35 KT AND SIS = 50 DEG.                  AIRWTBL   639
C  *                                                                           AIRWTBL   640
      DATA TABIVD/                                                             AIRWTBL   641
C                                                                              AIRWTBL   642
C  Y           X =    0.00    37.00   90.00   125.0   250.0      ZTAB = -14    AIRWTBL   643
C                                                                              AIRWTBL   644
     -18.75           3.94 , 13.75 , 15.98 , 12.69 , 12.96 ,                   AIRWTBL   645
        0.0          20.12 , 13.53 , 11.74 , 11.13 , 13.00 ,                   AIRWTBL   646
       18.75          8.96 , 10.00 , 12.10 , 11.14 , 11.71 ,                   AIRWTBL   647
       54.0          12.15 , 11.52 , 13.68 , 11.25 , 11.99 ,                   AIRWTBL   648
      104.0          10.55 , 10.93 , 10.67 , 11.67 , 10.66 ,                   AIRWTBL   649
C                                                                              AIRWTBL   650
C  Y           X =    0.00    37.00   90.00   125.0   250.0      ZTAB = -25    AIRWTBL   651
C                                                                              AIRWTBL   652
     -18.75           2.32 ,  8.42 , 17.09 , 15.06 , 12.98 ,                   AIRWTBL   653
        0.0          13.13 , 15.09 , 14.02 , 11.59 , 13.79 ,                   AIRWTBL   654
       18.75         15.15 , 13.79 , 13.13 , 13.31 , 11.18 ,                   AIRWTBL   655
       54.0           9.27 , 14.78 , 12.85 , 13.16 , 12.36 ,                   AIRWTBL   656
      104.0          15.58 , 13.20 , 12.43 , 11.33 , 10.00 ,                   AIRWTBL   657
C                                                                              AIRWTBL   658
C  Y           X =    0.00    37.00   90.00   125.0   250.0      ZTAB = -44    AIRWTBL   659
C                                                                              AIRWTBL   660
     -18.75           1.22 ,  3.25 ,  8.45 , 11.13 , 17.73 ,                   AIRWTBL   661
        0.0           2.56 , 10.31 , 14.31 , 13.23 , 16.21 ,                   AIRWTBL   662
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           18.75            2.96 , 15.10 , 17.30 , 15.75 , 15.85 ,                     AIRWTBL  663
            54.0            1.42 ,  2.99 , 13.60 , 13.14 , 16.92 ,                     AIRWTBL  664
           104.0           11.50 , 13.42 , 10.31 , 12.36 , 17.20 /                     AIRWTBL  665
        C   *                                                                          AIRWTBL  666
        C  ***     TABLE IVE. SIGMA VX AT VSS = 35 KT45ND SIS = 30 DEG.                AIRWTBL  667
        C   *                                                                          AIRWTBL  668
              DATA TABIVE/                                                             AIRWTBL  669
        C                                                                              AIRWTBL  670
        C   Y          X =    0.00   37.00   90.00   125.0   250.0     ZTAB = -14      AIRWTBL  671
        C                                                                              AIRWTBL  672
          -18.75            3.68 , 17.72 ,  7.19 ,  7.41 ,  6.15 ,                     AIRWTBL  673
             0.0           19.52 , 14.60 ,  9.73 ,  9.30 ,  6.77 ,                     AIRWTBL  674
           16.75           14.42 , 10.69 , 11.02 , 10.53 ,  9.03 ,                     AIRWTBL  675
            54.0           10.87 , 10.08 ,  9.71 , 10.40 ,  7.44 ,                     AIRWTBL  676
           104.0           10.43 , 11.36 ,  7.75 ,  6.89 ,  3.92 ,                     AIRWTBL  677
        C                                                                              AIRWTBL  678
        C   Y          X =    0.00   37.00   90.00   125.0   250.0     ZTAB = -25      AIRWTBL  679
        C                                                                              AIRWTBL  680
          -18.75            1.57 , 15.21 , 13.41 ,  9.54 ,  7.50 ,                     AIRWTBL  681
             0.C           13.18 , 16.02 , 10.63 ,  9.06 ,  7.52 ,                     AIRWTBL  682
           18.75           13.81 , 13.76 , 12.52 , 11.04 ,  9.08 ,                     AIRWTBL  683
            54.C           11.44 , 11.04 ,  9.65 ,  9.31 ,  4.51 ,                     AIRWTBL  684
           104.0           10.02 , 11.43 ,  8.05 ,  7.53 ,  4.28 ,                     AIRWTBL  685
        C                                                                              AIRWTBL  686
        C   Y          X =    0.00   37.00   90.00   125.0   250.0     ZTAB = -44      AIRWTBL  687
        C                                                                              AIRWTBL  688
          -18.75            0.77 ,  1.45 , 10.27 , 12.69 , 10.43 ,                     AIRWTBL  689
             0.0            1.18 ,  2.86 ,  9.93 , 12.19 , 10.07 ,                     AIRWTBL  690
           18.75            1.08 ,  3.42 ,  5.76 ,  8.43 , 11.55 ,                     AIRWTBL  691
            54.0            7.69 ,  8.94 ,  8.30 ,  5.84 ,  2.68 ,                     AIRWTBL  692
           104.0           11.74 , 10.56 ,  6.40 ,  6.04 ,  3.45 /                     AIRWTBL  693
        C   *                                                                          AIRWTBL  694
        C  ***     TABLE IVF. SIGMA VX AT VSS = 35 KT45ND SIS = 50 DEG.                AIRWTBL  695
        C   *                                                                          AIRWTBL  696
              DATA TABIVF/                                                             AIRWTBL  697
        C                                                                              AIRWTBL  698
        C   Y          X =    0.00   37.00   90.00   125.0   250.0     ZTAB = -14      AIRWTBL  699
        C                                                                              AIRWTBL  700
          -18.75            5.45 , 18.22 , 19.45 , 16.98 , 17.07 ,                     AIRWTBL  701
             0.0           23.31 , 20.14 , 14.66 , 15.20 , 16.16 ,                     AIRWTBL  702
           18.75           12.84 , 14.31 , 12.83 , 12.32 , 14.17 ,                     AIRWTBL  703
            54.0           16.43 , 15.70 , 14.42 , 15.95 , 14.40 ,                     AIRWTBL  704
           104.0           15.95 , 12.36 , 12.39 , 13.91 , 12.95 ,                     AIRWTBL  705
        C                                                                              AIRWTBL  706
        C   Y          X =    0.00   37.00   90.00   125.0   250.0     ZTAB = -25      AIRWTBL  707
        C                                                                              AIRWTBL  708
          -18.75            2.86 , 11.79 , 19.77 , 18.26 , 20.64 ,                     AIRWTBL  709
             0.0           16.91 , 20.76 , 18.35 , 15.91 , 18.57 ,                     AIRWTBL  710
           18.75           20.61 , 18.79 , 17.00 , 14.67 , 14.85 ,                     AIRWTBL  711
            54.0           17.50 , 18.49 , 18.86 , 17.57 , 16.76 ,                     AIRWTBL  712
           104.C           19.21 , 16.25 , 15.12 , 14.96 , 13.61 ,                     AIRWTBL  713
        C                                                                              AIRWTBL  714
        C   Y          X =    0.00   37.00   90.00   125.0   250.0     ZTAB = -44      AIRWTBL  715
        C                                                                              AIRWTBL  716
          -18.75            1.05 ,  3.72 , 12.02 , 16.17 , 16.40 ,                     AIRWTBL  717
             0.0            2.56 , 13.73 , 19.33 , 17.11 , 15.11 ,                     AIRWTBL  718
           18.75            4.22 , 20.34 , 23.52 , 19.86 , 14.93 ,                     AIRWTBL  719
          54.0              2.06 ,  4.75 , 15.93 , 17.C7 , 16.18 ,                   AIRWTBL   720
         104.0             15.19 , 16.43 , 14.13 , 13.59 , 13.23 /                   AIRWTBL   721
      C  *                                                                           AIRWTBL   722
      C  ***      TABLE VA. SIGMA VY AT VSS = 20 KT AND SIS = 30 DEG.                AIRWTBL   723
      C  *                                                                           AIRWTBL   724
               DATA TABVA/                                                           AIRWTBL   725
      C                                                                              AIRWTBL   726
      C  Y            X =   0.00   37.00   90.00   125.0   250.0      ZTAB = -14 AIRWTBL   727
      C                                                                              AIRWTBL   728
        -18.75              2.03 ,  8.37 ,  3.59 ,  3.78 ,  3.90 ,                   AIRWTBL   729
           0.0              6.21 ,  5.90 ,  4.87 ,  4.22 ,  4.12 ,                   AIRWTBL   730
         18.75              5.18 ,  4.10 ,  4.11 ,  3.88 ,  4.43 ,                   AIRWTBL   731
          54.0              4.21 ,  4.10 ,  5.43 ,  6.59 ,  3.07 ,                   AIRWTBL   732
         104.0              5.27 ,  4.05 ,  4.21 ,  2.63 ,  1.76 ,                   AIRWTBL   733
      C                                                                              AIRWTBL   734
      C  Y            X =   0.00   37.00   90.00   125.0   250.0      ZTAB = -25 AIRWTBL   735
      C                                                                              AIRWTBL   736
        -18.75              1.39 ,  4.74 ,  6.85 ,  5.61 ,  4.20 ,                   AIRWTBL   737
           0.0              6.58 ,  7.21 ,  6.18 ,  4.71 ,  3.86 ,                   AIRWTBL   738
         18.75              2.97 ,  6.22 ,  5.79 ,  5.87 ,  4.84 ,                   AIRWTBL   739
          54.0              4.95 ,  3.81 ,  4.87 ,  4.15 ,  2.71 ,                   AIRWTBL   740
         104.0              6.83 ,  5.53 ,  4.32 ,  2.66 ,  1.75 ,                   AIRWTBL   741
      C                                                                              AIRWTBL   742
      C  Y            X =   0.00   37.00   90.00   125.0   250.0      ZTAB = -44 AIRWTBL   743
      C                                                                              AIRWTBL   744
        -18.75              1.24 ,  1.26 ,  6.04 ,  5.80 ,  3.82 ,                   AIRWTBL   745
           0.0              1.20 ,  1.62 ,  5.31 ,  4.89 ,  3.75 ,                   AIRWTBL   746
         18.75              1.25 ,  1.45 ,  5.37 ,  6.24 ,  7.39 ,                   AIRWTBL   747
          54.0              4.74 ,  3.84 ,  4.00 ,  3.51 ,  2.38 ,                   AIRWTBL   748
         104.0              6.12 ,  3.95 ,  2.54 ,  2.50 ,  1.69 /                   AIRWTBL   749
      C  *                                                                           AIRWTBL   750
      C  ***      TABLE VB. SIGMA VY AT VSS = 20 KT AND SIS = 50 DEG.                AIRWTBL   751
      C  *                                                                           AIRWTBL   752
               DATA TABVB/                                                           AIRWTBL   753
      C                                                                              AIRWTBL   754
      C  Y            X =   0.00   37.00   90.00   125.0   250.0      ZTAB = -14 AIRWTBL   755
      C                                                                              AIRWTBL   756
        -18.75              3.13 ,  7.87 ,  9.27 ,  6.86 ,  5.85 ,                   AIRWTBL   757
           0.0              9.29 ,  7.31 ,  6.11 ,  5.74 ,  6.58 ,                   AIRWTBL   758
         18.75              5.01 ,  5.54 ,  5.33 ,  5.33 ,  6.53 ,                   AIRWTBL   759
          54.0              7.30 ,  5.76 ,  5.96 ,  7.07 ,  8.33 ,                   AIRWTBL   760
         104.0              4.48 ,  4.61 ,  4.85 ,  6.11 ,  6.22 ,                   AIRWTBL   761
      C                                                                              AIRWTBL   762
      C  Y            X =   0.00   37.00   90.00   125.0   250.0      ZTAB = -25 AIRWTBL   763
      C                                                                              AIRWTBL   764
        -18.75              1.82 ,  6.45 ,  8.75 ,  7.22 ,  6.75 ,                   AIRWTBL   765
           0.0              7.90 ,  8.28 ,  8.41 ,  6.22 ,  6.32 ,                   AIRWTBL   766
         18.75              9.34 ,  8.06 ,  7.59 ,  5.39 ,  6.83 ,                   AIRWTBL   767
          54.0              4.63 ,  5.56 ,  6.79 ,  7.10 ,  7.35 ,                   AIRWTBL   768
         104.0              6.14 ,  6.91 ,  6.23 ,  7.97 ,  7.08 ,                   AIRWTBL   769
      C                                                                              AIRWTBL   770
      C  Y            X =   0.00   37.00   90.00   125.0   250.0      ZTAB = -44 AIRWTBL   771
      C                                                                              AIRWTBL   772
        -18.75              1.16 ,  1.74 ,  6.74 ,  6.94 ,  6.79 ,                   AIRWTBL   773
           0.0              1.04 ,  4.96 ,  8.53 ,  8.39 ,  5.35 ,                   AIRWTBL   774
         18.75              1.45 ,  7.27 , 10.00 , 11.13 ,  8.85 ,                   AIRWTBL   775
          54.0              0.92 ,  2.05 ,  5.58 ,  5.70 ,  6.43 ,                   AIRWTBL   776
        104.C         7.41 ,  7.94 ,  7.11 ,  7.38 ,  4.23 /                       AIRWTBL   777
      C  *                                                                         AIRWTBL   778
      C  ***      TABLE VC. SIGMA VY AT VSS = 35 KT AND SIS = 30 DEG.              AIRWTBL   779
      C  *                                                                         AIRWTBL   780
           DATA TABVC/                                                             AIRWTBL   781
      C                                                                            AIRWTBL   782
      C  Y          X =     0.00   37.00   90.00   125.0   250.0      ZTAB = -14 AIRWTBL   783
      C                                                                            AIRWTBL   784
       -18.75                4.38 , 15.75 ,  9.24 ,  6.89 ,  6.89 ,               AIRWTBL   785
          0.C               12.89 , 13.57 ,  9.27 ,  8.24 ,  8.54 ,               AIRWTBL   786
         18.75              12.28 , 10.12 ,  8.41 ,  6.89 ,  7.69 ,               AIRWTBL   787
         54.C                8.71 ,  8.92 , 10.47 ,  9.74 ,  5.91 ,               AIRWTBL   788
        104.0               10.37 , 10.46 , 10.15 ,  6.14 ,  4.88 ,               AIRWTBL   789
      C                                                                            AIRWTBL   790
      C  Y          X =     0.00   37.00   90.00   125.0   250.0      ZTAB = -25 AIRWTBL   791
      C                                                                            AIRWTBL   792
       -18.75                2.42 ,  9.10 , 13.35 ,  9.80 ,  7.94 ,               AIRWTBL   793
          0.C               14.28 , 14.48 , 12.61 , 10.24 ,  8.31 ,               AIRWTBL   794
         18.75               8.41 , 11.36 , 14.52 , 12.33 , 10.03 ,               AIRWTBL   795
         54.0               10.95 ,  9.93 , 10.79 , 10.46 ,  4.58 ,               AIRWTBL   796
        104.0               11.90 , 11.86 ,  9.94 ,  6.23 ,  4.63 ,               AIRWTBL   797
      C                                                                            AIRWTBL   798
      C  Y          X =     0.00   37.00   90.00   125.0   250.0      ZTAB = -44 AIRWTBL   799
      C                                                                            AIRWTBL   800
       -18.75                1.31 ,  1.30 ,  8.32 , 12.15 , 12.68 ,               AIRWTBL   801
          0.C                1.07 ,  2.47 ,  8.76 , 11.42 , 12.66 ,               AIRWTBL   802
         18.75               1.48 ,  1.84 ,  8.64 ,  9.27 ,  14.32 ,              AIRWTBL   803
         54.0                8.82 ,  8.02 ,  7.57 ,  6.18 , 14.43 ,               AIRWTBL   804
        104.0               13.06 , 10.25 ,  8.79 ,  5.66 , 10.44 /               AIRWTBL   805
      C  *                                                                         AIRWTBL   806
      C  ***      TABLF VD. SIGMA VY AT VSS = 35 KT AND SIS = 50 DEG.              AIRWTBL   807
      C  *                                                                         AIRWTBL   808
           DATA TABVD/                                                             AIRWTBL   809
      C                                                                            AIRWTBL   810
      C  Y          X =     0.CC   37.00   90.00   125.0   250.0      ZTAB = -14 AIRWTBL   811
      C                                                                            AIRWTBL   812
       -18.75                6.01 , 13.75 , 17.04 , 13.54 , 13.51 ,               AIRWTBL   813
          0.0               17.96 , 13.38 , 14.25 , 11.57 , 13.17 ,               AIRWTBL   814
         18.75               9.45 , 11.77 , 11.39 , 11.31 , 11.90 ,               AIRWTBL   815
         54.0               13.75 , 11.20 , 12.70 , 11.83 , 15.07 ,               AIRWTBL   816
        104.0                9.34 ,  8.96 ,  9.71 , 12.52 , 13.54 ,               AIRWTBL   817
      C                                                                            AIRWTBL   818
      C  Y          X =     C.00   37.00   90.00   125.0   25C.0      ZTAB = -25 AIRWTBL   819
      C                                                                            AIRWTBL   820
       -18.75                3.41 , 10.49 , 17.78 , 15.39 , 13.14 ,               AIRWTBL   821
          0.0               12.86 , 16.87 , 15.53 , 13.53 , 12.53 ,               AIRWTBL   822
         18.75              16.41 , 14.31 , 15.11 , 12.56 , 12.70 ,               AIRWTBL   823
         54.C               10.20 , 12.57 , 14.11 , 14.16 , 12.75 ,               AIRWTBL   824
        104.0               15.00 , 12.81 , 11.09 , 13.C5 , 13.06 ,               AIRWTBL   825
      C                                                                            AIRWTBL   826
      C  Y          X =     0.00   37.00   9C.00   125.0   250.0      ZTAB = -44 AIRWTBL   827
      C                                                                            AIRWTBL   828
       -18.75                1.37 ,  2.82 , 10.59 , 11.89 , 17.13 ,               AIRWTBL   829
          0.C                2.40 , 10.42 , 14.75 , 15.72 , 16.43 ,               AIRWTBL   830
         18.75               2.26 , 17.06 , 18.72 , 18.64 , 16.91 ,               AIRWTBL   831
         54.0                2.16 ,  4.63 , 15.03 , 15.62 , 16.73 ,               AIRWTBL   832
        104.0               14.58 ; 14.67 , 15.33 , 14.93 , 17.08 /               AIRWTBL   833
      C  *                                                                      AIRWTBL   834
      C  ***    TABLE VF. SIGMA VY AT VSS = 45 KT AND SIS = 30 DEG.             AIRWTBL   835
      C  *                                                                      AIRWTBL   836
             DATA TABVE/                                                        AIRWTBL   837
      C                                                                         AIRWTBL   838
      C  Y          X =    0.00    37.00    90.00    125.0    250.0    ZTAB = -14 AIRWTBL   839
      C                                                                         AIRWTBL   840
      -18.75               5.18 ,  24.29 ,  10.90 ,  10.86 ,  11.39 ,           AIRWTBL   841
        0.0               16.50 ,  17.97 ,  11.51 ,  11.34 ,  10.58 ,           AIRWTBL   842
       18.75              16.93 ,  13.31 ,  12.08 ,  10.97 ,  12.32 ,           AIRWTBL   843
        54.0              11.98 ,  13.76 ,  14.33 ,  15.63 ,   9.64 ,           AIRWTBL   844
       104.0              13.49 ,  16.83 ,  12.93 ,   7.89 ,   5.39 ,           AIRWTBL   845
      C                                                                         AIRWTBL   846
      C  Y          X =    0.00    37.00    90.00    125.0    250.0    ZTAB = -25 AIRWTBL   847
      C                                                                         AIRWTBL   848
      -18.75               2.07 ,  15.23 ,  16.60 ,  13.42 ,  11.70 ,           AIRWTBL   849
        0.0               18.06 ,  22.53 ,  17.00 ,  13.17 ,  11.71 ,           AIRWTBL   850
       18.75              17.60 ,  19.36 ,  18.50 ,  16.56 ,  13.70 ,           AIRWTBL   851
        54.0              17.45 ,  16.06 ,  15.83 ,  15.73 ,   5.88 ,           AIRWTBL   852
       104.0              15.28 ,  16.56 ,  13.89 ,  10.44 ,   5.60 ,           AIRWTBL   853
      C                                                                         AIRWTBL   854
      C  Y          X =    0.00    37.00    90.00    125.0    250.0    ZTAB = -44 AIRWTBL   855
      C                                                                         AIRWTBL   856
      -18.75               1.08 ,   1.13 ,  12.18 ,  16.03 ,  14.61 ,           AIRWTBL   857
        0.0                1.14 ,   4.09 ,  12.59 ,  14.38 ,  13.76 ,           AIRWTBL   858
       18.75               1.27 ,   4.30 ,  11.14 ,  13.95 ,  16.03 ,           AIRWTBL   859
        54.0              11.69 ,  12.35 ,  12.59 ,   7.63 ,   3.40 ,           AIRWTBL   860
       104.0              15.37 ,  13.90 ,  12.45 ,  10.53 ,   3.83 /           AIRWTBL   861
      C  *                                                                      AIRWTBL   862
      C  ***    TABLE VF. SIGMA VY AT VSS = 45 KT AND SIS = 50 DEG.             AIRWTBL   863
      C  *                                                                      AIRWTBL   864
             DATA TABVF/                                                        AIRWTBL   865
      C                                                                         AIRWTBL   866
      C  Y          X =    0.00    37.00    90.00    125.0    250.0    ZTAB = -14 AIRWTBL   867
      C                                                                         AIRWTBL   868
      -18.75               7.10 ,  20.67 ,  22.41 ,  18.59 ,  17.69 ,           AIRWTBL   869
        0.0               26.10 ,  20.57 ,  17.02 ,  15.81 ,  15.73 ,           AIRWTBL   870
       18.75              11.93 ,  15.96 ,  14.03 ,  15.45 ,  16.90 ,           AIRWTBL   871
        54.0              18.06 ,  16.48 ,  15.96 ,  17.73 ,  17.88 ,           AIRWTBL   872
       104.0              14.55 ,  11.01 ,  10.66 ,  15.68 ,  16.77 ,           AIRWTBL   873
      C                                                                         AIRWTBL   874
      C  Y          X =    0.00    37.00    90.00    125.0    250.0    ZTAB = -25 AIRWTBL   875
      C                                                                         AIRWTBL   876
      -18.75               4.70 ,  13.77 ,  21.29 ,  20.51 ,  18.33 ,           AIRWTBL   877
        0.0               20.41 ,  25.70 ,  19.81 ,  19.08 ,  16.57 ,           AIRWTBL   878
       18.75              21.24 ,  23.84 ,  18.68 ,  18.31 ,  16.44 ,           AIRWTBL   879
        54.0              17.20 ,  17.05 ,  18.84 ,  15.89 ,  18.31 ,           AIRWTBL   880
       104.0              19.50 ,  13.98 ,  14.47 ,  17.16 ,  17.68 ,           AIRWTBL   881
      C                                                                         AIRWTBL   882
      C  Y          X =    0.00    37.00    90.00    125.0    250.0    ZTAB = -44 AIRWTBL   883
      C                                                                         AIRWTBL   884
      -18.75               1.19 ,   4.28 ,  14.92 ,  17.18 ,  17.58 ,           AIRWTBL   885
        0.0                2.63 ,  14.33 ,  21.28 ,  20.95 ,  16.31 ,           AIRWTBL   886
       18.75               3.50 ,  21.63 ,  27.21 ,  24.25 ,  19.59 ,           AIRWTBL   887
        54.0               2.58 ,   5.82 ,  18.01 ,  20.32 ,  16.61 ,           AIRWTBL   888
       104.0              16.77 ,  19.74 ,  18.93 ,  18.45 ,  15.37 /           AIRWTBL   889
      C  *                                                                      AIRWTBL   890
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              C  ***   TABLE VIA. SIGMA VZ AT VSS = 20 KT AND SIS = 30 DEG.                  AIRWTBL   891
 1085         C  *                                                                            AIRWTBL   892
                    DATA TABVIA/                                                              AIRWTBL   893
              C                                                                               AIRWTBL   894
              C  Y          X =     0.00    37.00    90.00    125.0    250.0    ZTAB = -14 AIRWTBL   895
              C                                                                               AIRWTBL   896
 1090        -18.75                 2.11 ,  5.73 ,  4.13 ,  3.24 ,  3.18 ,                    AIRWTBL   897
                0.0                 5.55 ,  6.43 ,  5.76 ,  5.08 ,  3.60 ,                    AIRWTBL   898
               18.75                4.41 ,  5.04 ,  5.05 ,  4.76 ,  4.12 ,                    AIRWTBL   899
               54.0                 4.98 ,  4.65 ,  4.16 ,  4.10 ,  3.39 ,                    AIRWTBL   900
              104.0                 5.40 ,  4.30 ,  4.66 ,  3.07 ,  1.97 ,                    AIRWTBL   901
 1095         C                                                                               AIRWTBL   902
              C  Y          X =     0.00    37.00    90.00    125.0    250.0    ZTAB = -25 AIRWTBL   903
              C                                                                               AIRWTBL   904
             -18.75                 1.05 ,  4.93 ,  7.05 ,  4.92 ,  3.28 ,                    AIRWTBL   905
                0.0                 5.80 ,  5.70 ,  6.08 ,  6.00 ,  4.21 ,                    AIRWTBL   906
 1100          18.75                2.08 ,  5.05 ,  5.31 ,  5.87 ,  3.59 ,                    AIRWTBL   907
               54.0                 4.40 ,  3.93 ,  4.39 ,  4.08 ,  2.34 ,                    AIRWTBL   908
              104.0                 7.45 ,  6.54 ,  4.87 ,  3.08 ,  1.53 ,                    AIRWTBL   909
              C                                                                               AIRWTBL   910
              C  Y          X =     0.00    37.00    90.00    125.0    250.0    ZTAB = -44 AIRWTBL   911
 1105         C                                                                               AIRWTBL   912
             -18.75                 0.89 ,  1.43 ,  5.05 ,  6.35 ,  4.46 ,                    AIRWTBL   913
                0.0                 1.21 ,  1.99 ,  5.99 ,  5.02 ,  3.93 ,                    AIRWTBL   914
               18.75                1.16 ,  1.04 ,  3.71 ,  4.94 ,  8.86 ,                    AIRWTBL   915
               54.0                 4.46 ,  3.22 ,  3.71 ,  2.82 ,  1.41 ,                    AIRWTBL   916
 1110         104.0                 5.78 ,  4.15 ,  2.10 ,  1.96 ,  1.24 /                    AIRWTBL   917
              C  *                                                                            AIRWTBL   918
              C  ***   TABLE VIB. SIGMA VZ AT VSS = 20 KT AND SIS = 50 DEG.                  AIRWTBL   919
              C  *                                                                            AIRWTBL   920
                    DATA TABVIB/                                                              AIRWTBL   921
 1115         C                                                                               AIRWTBL   922
              C  Y          X =     0.00    37.00    90.00    125.0    250.0    ZTAB = -14 AIRWTBL   923
              C                                                                               AIRWTBL   924
             -18.75                 2.36 ,  5.79 ,  6.79 ,  6.28 ,  5.59 ,                    AIRWTBL   925
                0.0                 7.85 ,  7.22 ,  7.76 ,  6.77 ,  5.86 ,                    AIRWTBL   926
 1120          18.75                5.45 ,  5.36 ,  6.19 ,  6.15 ,  4.93 ,                    AIRWTBL   927
               54.0                 6.07 ,  5.94 ,  5.35 ,  6.01 ,  6.19 ,                    AIRWTBL   928
              104.0                 5.33 ,  5.22 ,  5.44 ,  6.33 ,  6.03 ,                    AIRWTBL   929
              C                                                                               AIRWTBL   930
              C  Y          X =     0.00    37.00    90.00    125.0    250.0    ZTAB = -25 AIRWTBL   931
 1125         C                                                                               AIRWTBL   932
             -18.75                 1.31 ,  5.64 ,  7.93 ,  7.68 ,  6.57 ,                    AIRWTBL   933
                0.0                 7.47 ,  7.26 ,  7.41 ,  6.34 ,  6.22 ,                    AIRWTBL   934
               18.75                8.01 ,  7.82 ,  7.41 ,  7.05 ,  5.11 ,                    AIRWTBL   935
               54.0                 4.42 ,  5.93 ,  7.49 ,  6.53 ,  6.03 ,                    AIRWTBL   936
 1130         104.0                 7.07 ,  7.39 ,  5.72 ,  6.53 ,  6.85 ,                    AIRWTBL   937
              C                                                                               AIRWTBL   938
              C  Y          X =     0.00    37.00    90.00    125.0    250.0    ZTAB = -44 AIRWTBL   939
              C                                                                               AIRWTBL   940
             -18.75                 0.85 ,  2.14 ,  5.12 ,  7.10 ,  6.57 ,                    AIRWTBL   941
 1135           0.0                 1.28 ,  6.88 ,  7.92 ,  7.59 ,  7.26 ,                    AIRWTBL   942
               18.75                1.72 ,  8.77 ,  9.18 , 11.00 , 10.25 ,                    AIRWTBL   943
               54.0                 1.00 ,  2.16 ,  5.55 ,  6.12 ,  6.43 ,                    AIRWTBL   944
              104.0                 7.06 ,  7.76 ,  6.50 ,  5.67 ,  3.69 /                    AIRWTBL   945
              C  *                                                                            AIRWTBL   946
 1140         C  ***   TABLE VIC. SIGMA VZ AT VSS = 35 KT AND SIS = 30 DEG.                  AIRWTBL   947
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```
      C  *                                                                       AIRWTBL  948
            DATA TABVIC/                                                         AIRWTBL  949
      C                                                                          AIRWTBL  950
      C  Y         X =     0.00    37.00    90.00   125.0   250.0    ZTAB = -14  AIRWTBL  951
      C                                                                          AIRWTBL  952
   -18.75                 3.99 , 12.17 ,  8.50 ,  7.49 ,  6.56 ,                 AIRWTBL  953
     0.0                 12.09 , 13.00 , 11.14 ,  9.96 ,  8.01 ,                 AIRWTBL  954
    18.75                11.10 , 11.53 , 10.72 , 10.90 , 10.33 ,                 AIRWTBL  955
     54.0                12.43 , 10.51 ,  9.08 ,  9.02 ,  6.89 ,                 AIRWTBL  956
    104.0                 8.12 ,  8.91 ,  9.63 ,  7.33 ,  4.27 ,                 AIRWTBL  957
      C                                                                          AIRWTBL  958
      C  Y         X =     0.00    37.00    90.00   125.0   250.0    ZTAB = -25  AIRWTBL  959
      C                                                                          AIRWTBL  960
   -18.75                 2.05 ,  9.18 , 12.77 ,  9.99 ,  6.55 ,                 AIRWTBL  961
     0.0                 12.14 , 11.18 , 10.99 , 11.40 ,  7.46 ,                 AIRWTBL  962
    18.75                 4.91 , 10.40 , 11.64 ,  9.92 ,  9.43 ,                 AIRWTBL  963
     54.0                10.50 , 10.43 , 10.25 ,  8.78 ,  3.83 ,                 AIRWTBL  964
    104.0                11.05 , 10.61 ,  9.14 ,  6.60 ,  3.31 ,                 AIRWTBL  965
      C                                                                          AIRWTBL  966
      C  Y         X =     0.00    37.00 .  90.00   125.0   250.0    ZTAB = -44  AIRWTBL  967
      C                                                                          AIRWTBL  968
   -18.75                 1.06 ,  1.95 ,  8.16 , 11.81 , 10.46 ,                 AIRWTBL  969
     0.0                  1.56 ,  3.30 ,  8.56 , 11.93 , 12.85 ,                 AIRWTBL  970
    18.75                 1.24 ,  2.84 ,  4.19 ,  6.60 , 15.10 ,                 AIRWTBL  971
     54.0                 6.65 ,  6.33 ,  6.34 ,  5.23 , 12.23 ,                 AIRWTBL  972
    104.0                11.54 ,  8.52 ,  5.79 ,  3.91 ,  9.85 /                 AIRWTBL  973
      C  *                                                                       AIRWTBL  974
      C  ***      TABLE VID. SIGMA VZ AT VSS = 35 KT AND SIS = 50 DEG.           AIRWTBL  975
      C  *                                                                       AIRWTBL  976
            DATA TABVID/                                                         AIRWTBL  977
      C                                                                          AIRWTBL  978
      C  Y         X =     0.00    37.00    90.00   125.0   250.0    ZTAB = -14  AIRWTBL  979
      C                                                                          AIRWTBL  980
   -18.75                 4.62 , 11.59 , 13.94 , 12.46 , 11.64 ,                 AIRWTBL  981
     0.0                 17.21 , 12.85 , 14.52 , 12.37 , 11.29 ,                 AIRWTBL  982
    18.75                10.92 , 10.50 , 13.39 , 12.17 , 11.03 ,                 AIRWTBL  983
     54.0                11.56 , 11.41 , 12.93 , 11.79 , 11.53 ,                 AIRWTBL  984
    104.0                10.55 ,  9.78 ,  8.97 , 11.25 , 11.74 ,                 AIRWTBL  985
      C                                                                          AIRWTBL  986
      C  Y         X =     0.00    37.00    90.00   125.0   250.0    ZTAB = -25  AIRWTBL  987
      C                                                                          AIRWTBL  988
   -18.75                 2.71 ,  8.82 , 14.05 , 13.83 , 13.21 ,                 AIRWTBL  989
     0.0                 13.35 , 13.63 , 14.80 , 12.83 , 10.51 ,                 AIRWTBL  990
    18.75                14.83 , 12.99 , 14.25 , 13.96 , 11.03 ,                 AIRWTBL  991
     54.0                11.61 , 12.63 , 14.82 , 13.12 , 11.27 ,                 AIRWTBL  992
    104.0                14.17 , 11.87 , 10.85 , 10.80 , 10.92 ,                 AIRWTBL  993
      C                                                                          AIRWTBL  994
      C  Y         X =     0.00    37.00    90.00   125.0   250.0    ZTAB = -44  AIRWTBL  995
      C                                                                          AIRWTBL  996
   -18.75                 1.39 ,  3.00 ,  9.07 , 12.35 , 16.21 ,                 AIRWTBL  997
     0.0                  3.79 , 11.59 , 15.66 , 14.01 , 15.67 ,                 AIRWTBL  998
    18.75                 4.25 , 15.53 , 17.52 , 17.56 , 17.93 ,                 AIRWTBL  999
     54.0                 1.90 ,  4.28 , 12.71 , 13.46 , 17.11 ,                 AIRWTBL 1000
    104.0                14.39 , 15.05 , 12.84 , 12.78 , 15.87 /                 AIRWTBL 1001
      C  *                                                                       AIRWTBL 1002
      C  ***      TABLE VIE. SIGMA VZ AT VSS = 45 KT AND SIS = 30 DEG.           AIRWTBL 1003
      C  *                                                                       AIRWTBL 1004
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        DATA TABVIE/                                                    AIRWTBL  1005
C                                                                       AIRWTBL  1006
C  Y          X =    0.00    37.00    90.00    125.0    250.0    ZTAB = -14 AIRWTBL  1007
C                                                                       AIRWTBL  1008
-18.75               5.93 , 15.74 , 10.25 ,  9.73 ,  8.59 ,             AIRWTBL  1009
   0.0              16.06 , 18.09 , 13.89 , 11.81 ,  9.50 ,             AIRWTBL  1010
 18.75              16.15 , 16.73 , 13.95 , 14.26 , 13.72 ,             AIRWTBL  1011
  54.0              16.65 , 15.87 , 11.60 , 11.64 ,  8.86 ,             AIRWTBL  1012
 104.0              10.75 , 14.76 , 11.24 ,  9.59 ,  6.52 ,             AIRWTBL  1013
C                                                                       AIRWTBL  1014
C  Y          X =    0.00    37.00    90.00    125.0    250.0    ZTAB = -25 AIRWTBL  1015
C                                                                       AIRWTBL  1016
-18.75               1.79 , 14.19 , 15.60 , 13.16 ,  9.24 ,             AIRWTBL  1017
   0.0              14.15 , 15.01 , 16.36 , 14.66 ,  9.68 ,             AIRWTBL  1018
 18.75              14.49 , 17.16 , 16.26 , 15.32 , 13.62 ,             AIRWTBL  1019
  54.0              15.08 , 16.05 , 13.56 , 12.22 ,  5.64 ,             AIRWTBL  1020
 104.0              13.45 , 15.69 , 11.26 ,  8.90 ,  4.97 ,             AIRWTBL  1021
C                                                                       AIRWTBL  1022
C  Y          X =    0.00    37.00    90.00    125.0    250.0    ZTAB = -44 AIRWTBL  1023
C                                                                       AIRWTBL  1024
-18.75               0.98 ,  1.61 , 11.60 , 16.47 , 11.90 ,             AIRWTBL  1025
   0.0               1.58 ,  3.97 , 12.29 , 16.01 , 12.19 ,             AIRWTBL  1026
 18.75               1.15 ,  2.98 ,  5.91 ,  9.36 , 12.60 ,             AIRWTBL  1027
  54.0              10.15 , 10.48 ,  9.45 ,  5.20 ,  2.36 ,             AIRWTBL  1028
 104.0              13.03 , 11.39 ,  8.13 ,  6.83 ,  3.88 /             AIRWTBL  1029
C  *                                                                    AIRWTBL  1030
C  ***     TABLE VIF. SIGMA VZ AT VSS = 45 KT AND SIS = 50 DEG.         AIRWTBL  1031
C  *                                                                    AIRWTBL  1032
        DATA TABVIF/                                                    AIRWTBL  1033
C                                                                       AIRWTBL  1034
C  Y          X =    0.00    37.00    90.00    125.0    250.0    ZTAB = -14 AIRWTBL  1035
C                                                                       AIRWTBL  1036
-18.75               8.11 , 17.01 , 17.54 , 17.60 , 15.57 ,             AIRWTBL  1037
   0.0              20.48 , 19.33 , 16.36 , 15.74 , 14.31 ,             AIRWTBL  1038
 18.75              12.41 , 14.11 , 13.04 , 14.33 , 13.47 ,             AIRWTBL  1039
  54.0              16.76 , 15.38 , 14.29 , 16.47 , 14.92 ,             AIRWTBL  1040
 104.0              14.25 , 13.52 , 11.15 , 11.50 , 16.63 ,             AIRWTBL  1041
C                                                                       AIRWTBL  1042
C  Y          X =    0.00    37.00    90.00    125.0    250.0    ZTAB = -25 AIRWTBL  1043
C                                                                       AIRWTBL  1044
-18.75               5.09 , 12.43 , 19.53 , 18.96 , 16.70 ,             AIRWTBL  1045
   0.0              18.46 , 19.58 , 17.42 , 15.40 , 14.12 ,             AIRWTBL  1046
 18.75              19.50 , 17.39 , 17.83 , 16.09 , 14.11 ,             AIRWTBL  1047
  54.0              14.84 , 19.87 , 20.11 , 16.29 , 16.56 ,             AIRWTBL  1048
 104.0              17.15 , 14.66 , 13.98 , 13.86 , 14.68 ,             AIRWTBL  1049
C                                                                       AIRWTBL  1050
C  Y          X =    0.00    37.00    90.00    125.0    250.0    ZTAB = -44 AIRWTBL  1051
C                                                                       AIRWTBL  1052
-18.75               1.42 ,  3.89 , 13.32 , 15.39 , 15.34 ,             AIRWTBL  1053
   0.0               4.41 , 16.07 , 20.94 , 20.21 , 15.50 ,             AIRWTBL  1054
 18.75               5.99 , 20.17 , 26.03 , 21.22 , 18.23 ,             AIRWTBL  1055
  54.0               2.21 ,  5.90 , 15.69 , 17.49 , 14.31 ,             AIRWTBL  1056
 104.0              18.39 , 19.33 , 17.83 , 16.77 , 12.77 /             AIRWTBL  1057
C                                                                       AIRWTBL  1058
        DATA TABWOD / 20.0 , 35.0 , 45.0 /                              AIRWTBL  1059
C  *                                                                    AIRWTBL  1060
C  ***                  30.0               50.0                         AIRWTBL  1061
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      C  *                                                             AIRWTBL  1062
            DATA THIRTY , FIFTY / .52359878 , .87266463 /              AIRWTBL  1063
      C  *                                                             AIRWTBL  1064
      C  ***    FIND SECTION OF TABLE TO BE INTERPOLATED               AIRWTBL  1065
      C  *                                                             AIRWTBL  1066
            WOD             = VWOD/1.69                                AIRWTBL  1067
            RATPSI          = 1.0                                      AIRWTBL  1068
            IF(PSIS.GE.FIFTY) RATPSI = 0.0                             AIRWTBL  1069
            IF(PSIS.GT.THIRTY .AND. PSIS.LT.FIFTY)                     AIRWTBL  1070
          1 RATPSI          = (FIFTY - PSIS)/(FIFTY - THIRTY)          AIRWTBL  1071
            I               = 2                                        AIRWTBL  1072
            RATWOD          = 1.0                                      AIRWTBL  1073
            IF(WOD.LE.TABWOD(1)) GO TO 20                              AIRWTBL  1074
            DO 10 I=2,3                                                AIRWTBL  1075
            IF(WOD.GT.TABWOD(I)) GO TO 10                              AIRWTBL  1076
            RATWOD          = (TABWOD(I) - WOD)/(TABWOD(I) - TABWOD(I-1))  AIRWTBL  1077
            GO TO 20                                                   AIRWTBL  1078
      C                                                                AIRWTBL  1079
         10 CONTINUE                                                   AIRWTBL  1080
            I               = 3                                        AIRWTBL  1081
            RATWOD          = 0.0                                      AIRWTBL  1082
      C  *                                                             AIRWTBL  1083
      C  ***    INTERPOLATE                                            AIRWTBL  1084
      C  *                                                             AIRWTBL  1085
         20 CONTINUE                                                   AIRWTBL  1086
            DO 60 I3=1,18                                              AIRWTBL  1087
            KK              = 6*((I3 + 2)/3 - 1)                       AIRWTBL  1088
            KK              = 3*KK + I3 - 3*((I3 - 1)/3) - 3           AIRWTBL  1089
            DO 50 I2=1,5                                               AIRWTBL  1090
            DO 40 I1=1,5                                               AIRWTBL  1091
            II              = I                                        AIRWTBL  1092
            DO 30 JJ=1,2                                               AIRWTBL  1093
            LL              = KK + 6*II                                AIRWTBL  1094
            XDUM1           = TAB1(I1,I2,LL) - RATPSI*(TAB1(I1,I2,LL) -  AIRWTBL  1095
          1                   TAB1(I1,I2,LL-3))                        AIRWTBL  1096
            IF(JJ.EQ.1) XDUM2 = XDUM1                                  AIRWTBL  1097
            II              = II - 1                                   AIRWTBL  1098
         30 CONTINUE                                                   AIRWTBL  1099
            TAB2(I1,I2,I3) = XDUM2 - RATWOD*(XDUM2 - XDUM1)            AIRWTBL  1100
         40 CONTINUE                                                   AIRWTBL  1101
         50 CONTINUE                                                   AIRWTBL  1102
         60 CONTINUE                                                   AIRWTBL  1103
            RETURN                                                     AIRWTBL  1104
            END                                                        AIRWTBL  1105
      SUBROUTINE AXIS(XPAGE,YPAGE,IFCD,NCHAR,AXLEN,ANGLE,FIRSTV,DELTAV)  AXIS       2
C***********************************************************************  AXIS       3
C*                                                                     *  AXIS       4
C*       ROUTINE TC DRAW AN AXIS LINE ON THE CALCOMP PLOTTER.          *  AXIS       5
C*                                                                     *  AXIS       6
C*    INPUT ARGUMENTS                                                  *  AXIS       7
C*         XPAGE      CALCOMP X COORDINATE OF START OF AXIS LINE.      *  AXIS       8
C*         YPAGE      CALCOMP Y COORDINATE OF START OF AXIS LINE.      *  AXIS       9
C*         IBCD       TITLE TO BE CENTERED AND PLACED PARALLEL TO LINE. *  AXIS      10
C*         NCHAR      IABS(NCHAR)=NUMBER OF CHARACTERS IN TITLE.       *  AXIS      11
C*                    SIGN(NCHAR)=0,ANNOTATICN ON POSITIVE SIDE CF LINE. *  AXIS      12
C*                    SIGN(NCHAR)=1,ANNOTATION ON NEGATIVE SIDE CF LINE. *  AXIS      13
C*         AXLEN      AXIS LENGTH (INCHES).                            *  AXIS      14
C*         ANGLE      LINE ROTATION ANGLE (DEGREES).                   *  AXIS      15
C*         FIRSTV     STARTING VALUE TO BE PLACED ON AXIS.             *  AXIS      16
C*         DELTAV     INCREMENT PER INCH ON LINE.                      *  AXIS      17
C*                                                                     *  AXIS      18
C***********************************************************************  AXIS      19
      XP      = ANCLE/57.29579                                            AXIS      20
      SINE    = SIN(XP)                                                   AXIS      21
      COSINE  = COS(XP)                                                   AXIS      22
      XP      = XPAGE                                                     AXIS      23
      YP      = YPAGE                                                     AXIS      24
      CALL PLOT(XP,YP,3)                                                  AXIS      25
C                                                                       C AXIS      26
C**************FIND THE NUMBER OF DECIMALS TO BE PRINTED **************C AXIS      27
C                                                                       C AXIS      28
      DELN    = 0.2                                                       AXIS      29
      IF(NCHAR.LT.C) DELN = -0.2                                          AXIS      30
      FPN     = ABS(FIRSTV + DELTAV*AXLEN)                                AXIS      31
      IF(ABS(FIRSTV).GT.FPN) FPN = ABS(FIPSTV)                            AXIS      32
      NDEC    = 2                                                         AXIS      33
      IF(FPN.EQ.0.0.OR.FPN.EQ.1.0) GO TO 1C                               AXIS      34
      NDEC    = IFIX(ALOG10(FPN))                                         AXIS      35
      IF(FPN.GT.1.0.AND.FPN.GT.(1C.0**NDEC)) NDEC = NDEC + 1              AXIS      36
      NDEC    = 2 - NDEC                                                  AXIS      37
   10 DEL     = -C.1*FLOAT((NDEC+1)/2)                                    AXIS      38
      IF(NDEC.LT.2) DEL  =-0.2                                            AXIS      39
      IF(NDEC.GT.8) NDEC = 8                                              AXIS      40
      IF(NDEC.LT.0) NDEC =-1                                              AXIS      41
C                                                                       C AXIS      42
C**************                PLOT AXIS LINE               ***********C AXIS      43
C                                                                       C AXIS      44
      FPN     = FIRSTV                                                    AXIS      45
      N       = AXLEN + 1.0                                               AXIS      46
      DO 30 I=1,N                                                         AXIS      47
      CALL SYMBOL(XP,YP,0.1,13,ANGLE,-1)                                  AXIS      48
      X       = XP - DELN*SINE                                            AXIS      49
      Y       = YP + DELN*COSINE                                          AXIS      50
      IF(ABS(FPN).LE.1.0E-07) GO TO 20                                    AXIS      51
      X       = XP + DEL*COSINE - DELN*SINE                               AXIS      52
      Y       = YP + DEL*SINE + DELN*COSINE                               AXIS      53
   20 CALL NUMBER(X,Y,0.1,FPN,ANGLE,NDEC)                                 AXIS      54
      IF(I.EQ.N) GO TO 30                                                 AXIS      55
      CALL PLOT(XP,YP,3)                                                  AXIS      56
      XP      = XP + COSINE                                               AXIS      57
      YP      = YP + SINE                                                 AXIS      58
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SUBROUTINE AXIS         74/74    CPT=1                                FTN 4.6+428        12/08/78  15.13.13        PAGE     2

                  CALL PLOT(XP,YP,2)                                                          AXIS      59
                  FPN      = FPN + DELTAV                                                     AXIS      60
             30   CONTINUE                                                                    AXIS      61
                  DEL      = 0.5*AXLEN - ABS(0.05*FLOAT(NCHAR))                               AXIS      62
                  DELN     = 0.4                                                              AXIS      63
                  IF(NCHAR.LT.0) DELN = -0.4                                                  AXIS      64
                  X        = DEL*COSINE - DELN*SINE                                           AXIS      65
                  Y        = DEL*SINE + DELN*COSINE                                           AXIS      66
                  CALL SYMBOL(X,Y,0.1,IBCD,ANGLE,IABS(NCHAR))                                 AXIS      67
                  RETURN                                                                      AXIS      68
                  END                                                                         AXIS      69
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      SUBROUTINE CALPLT(ROW,NLIST,NPRNT)                                CALPLT    2
C*********************************************************************** CALPLT    3
C*                                                                     * CALPLT    4
C*      GENERALIZED CALCOMP PLOT ROUTINE.                              * CALPLT    5
C*                                                                     * CALPLT    6
C*   INPUT ARGUMENTS                                                   * CALPLT    7
C*      ROW(1)     SCRATCH ARRAY TO BE USED WHEN READING DATA FILE.    * CALPLT    8
C*      NLIST      FILE CONTAINING INPUT INSTRUCTIONS.                 * CALPLT    9
C*      NPRNT      =0 IF INPUT INSTRUCTIONS ARE NOT TO BE PLAYED BACK  * CALPLT   10
C*                 ON THE OUTPUT FILE.                                 * CALPLT   11
C*                                                                     * CALPLT   12
C*   DEFINITIONS                                                       * CALPLT   13
C*      I          =4HC.M. IF PLOTTING ON CENTIMETER PAPER.            * CALPLT   14
C*      NPLOTS     NUMBER OF PLOTS TO BE PRODUCED.                     * CALPLT   15
C*                                                                     * CALPLT   16
C*   DEFINITIONS FOR PLOT DATA                                         * CALPLT   17
C*      ANGLE      PLOT ROTATION ANGLE (DEGREES).                      * CALPLT   18
C*      DELX       INCREMENT PER INCH ON X AXIS.                       * CALPLT   19
C*      DELY       INCREMENT PER INCH ON Y AXIS.                       * CALPLT   20
C*      ISOPT      BIT ARRAY FOR SPECIAL OPTIONS.                      * CALPLT   21
C*                 BIT(0)=1 READ TITLE TO BE CENTERED OVER PLOT.       * CALPLT   22
C*                 BIT(1)=1 READ X AXIS LABEL.                         * CALPLT   23
C*                 BIT(2)=1 READ Y AXIS LABEL.                         * CALPLT   24
C*                 BIT(3)=1 READ LEGEND TITLE.                         * CALPLT   25
C*                 BIT(4)=1 READ TITLE AND COORDINATES.                * CALPLT   26
C*      LABELX     X AXIS LABEL.                                       * CALPLT   27
C*      LABELY     Y AXIS LABEL.                                       * CALPLT   28
C*      LNGTHX     LENGTH OF X AXIS (INCHES).                          * CALPLT   29
C*      LNGTHY     LENGTH OF Y AXIS (INCHES).                          * CALPLT   30
C*      NCURVS     NUMBER OF CURVES APPEARING ON THIS PLOT.            * CALPLT   31
C*      STARTX     INITIAL X VALUE.                                    * CALPLT   32
C*      STARTY     INITIAL Y VALUE.                                    * CALPLT   33
C*      XEXIT      FINAL HORIZONTAL PEN MOVEMENT (INCHES).             * CALPLT   34
C*      XLEGND     X COORDINATE (REL TO XPLOT) OF PLOT LEGEND (INCHES)* CALPLT   35
C*      XORG       X VALUE AT WHICH AXES INTERCEPT (DEFAULT=0.0).      * CALPLT   36
C*      XPLOT      INITIAL HORIZONTAL PEN MOVEMENT (INCHES).           * CALPLT   37
C*      YEXIT      FINAL VERTICAL PEN MOVEMENT (INCHES).               * CALPLT   38
C*      YLEGND     Y COORDINATE (REL TO YPLOT) OF PLOT LEGEND (INCHES)* CALPLT   39
C*      YORG       Y VALUE AT WHICH AXES INTERCEPT (DEFAULT=0.0).      * CALPLT   40
C*      YPLOT      INITIAL VERTICAL PEN MOVEMENT (INCHES).             * CALPLT   41
C*                                                                     * CALPLT   42
C*   DEFINITIONS FOR CURVE DATA                                        * CALPLT   43
C*      DASH       LENGTH OF PLOTTING SEGMENTS IN DASH PLOT (INCHES).  * CALPLT   44
C*      LINTYP     LINE TYPE.                                          * CALPLT   45
C*                 =0 IF NO SYMBOLS (LINE ONLY).                       * CALPLT   46
C*                 =- IF NO LINE     (SYMBOLS ONLY).                   * CALPLT   47
C*                 =+ IF BOTH LINE AND SYMBOLS ARE TO BE PRODUCED.     * CALPLT   48
C*      LSTYLE     LINE STYLE.                                         * CALPLT   49
C*      NCOLX      COLUMN ON DATA FILE WHERE X DATA RESIDES.           * CALPLT   50
C*      NCOLY      COLUMN ON DAT/ FILE WHERE Y DATA RESIDES.           * CALPLT   51
C*      NCX        COLUMN WHERE X ELLIPTICAL AXIS DATA RESIDES.        * CALPLT   52
C*      NCY        COLUMN WHERE Y ELLIPTICAL AXIS DATA RESIDES.        * CALPLT   53
C*      NCXY       COLUMN WHERE XY CROSS CORRELATION DATA RESIDES      * CALPLT   54
C*      NDATA      FILE WHERE DATA RESIDES.                            * CALPLT   55
C*      NSYM       CALCOMP SYMBOL CODE (99 IF ELLIPSE).                * CALPLT   56
C*      SCALEX     SCALE FACTOR TO BE APPLIED TO X DATA.               * CALPLT   57
C*      SCALEY     SCALE FACTOR TO BE APPLIED TO Y DATA.               * CALPLT   58
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      C*        SCALXX    SCALE FACTOR FOR X ELLIPTICAL AXIS (DEFAULT=SCALEX)* CALPLT     59
      C*        SCALYY    SCALE FACTOR FOR Y ELLIPTICAL AXIS (DEFAULT=SCALEY)* CALPLT     60
      C*                                                                     * CALPLT     61
      C********************************************************************** CALPLT     62
            DIMENSION KOW(1),TITLE(32),LABELX(4),LABELY(4)                     CALPLT     63
            REAL      LNGTHX,LNGTHY                                            CALPLT     64
            NAMELIST/PLCTD/ NCURVS,ANGLE,XPLOT,YPLOT,XEXIT,YEXIT,XLEGND,       CALPLT     65
           A                YLEGND,XORG,YORG,LNGTHX,LNGTHY,STARTX,STARTY,      CALPLT     66
           B                DELX,DELY,ISOPT                                    CALPLT     67
            NAMELIST/CURVE/ NDATA,NCOLX,NCOLY,NCX,NCY,NCXY,LINTYP,DASH,NSYM,   CALPLT     68
           *                SCALEX,SCALEY,SCALXX,SCALYY                        CALPLT     69
            DATA BLANK,LSMAX/ 10H          , 1777778 /                         CALPLT     70
      C                                                                      C CALPLT     71
      C***************          SET UP PLOTTING LOOP          ***************C CALPLT     72
      C                                                                      C CALPLT     73
            IF(NLIST.NE.5) REWIND NLIST                                        CALPLT     74
            READ(NLIST,1000) NPLOTS,I                                          CALPLT     75
      1000  FORMAT(I5,5X,A4)                                                   CALPLT     76
            IF(NPRNT.GT.C) WRITE(6,2000) NPLOTS                                CALPLT     77
      2000  FORMAT(//5X,I5)                                                    CALPLT     78
            IF(I.EQ.4HC.M.) CALL FACTOR(0.7874015748)                          CALPLT     79
            DO 310 I=1,NPLOTS                                                  CALPLT     80
            READ(NLIST,PLOTD)                                                  CALPLT     81
            CALL PLOT(XPLOT,YPLOT,-3)                                          CALPLT     82
            IF(ANGLE.NE.0.0) ANGLE = 90.0                                      CALPLT     83
      C                                                                      C CALPLT     84
      C***************          READ SPECIAL OPTIONS          ***************C CALPLT     85
      C                                                                      C CALPLT     86
            DO 140 J=1,5                                                       CALPLT     87
            K         = ISOPT.AND.SHIFT(MASK(1),J)                             CALPLT     88
            IF(K.EQ.0) GO TO 140                                               CALPLT     89
            GO TO (10,20,30,40,50),J                                           CALPLT     90
      C  *                                                                     CALPLT     91
      C  ***    READ AND PRODUCE A CENTERED PLOT TITLE.                        CALPLT     92
      C  *                                                                     CALPLT     93
      10    READ(NLIST,1010) TITLE                                             CALPLT     94
      1010  FORMAT(8A10)                                                       CALPLT     95
            IF(NPRNT.GT.C) WRITE(6,2010) TITLE                                 CALPLT     96
      2010  FORMAT(5X,8A10)                                                    CALPLT     97
            NC        = 80                                                     CALPLT     98
            NL        = 4                                                      CALPLT     99
            X         = 0.5*LNGTHX - 4.0                                       CALPLT    100
            Y         = LNGTHY + 1.0                                           CALPLT    101
            GO TO 110                                                          CALPLT    102
      C  *                                                                     CALPLT    103
      C  ***    READ X-AXIS LABEL.                                             CALPLT    104
      C  *                                                                     CALPLT    105
      20    READ(NLIST,1010) LABELX                                            CALPLT    106
            GO TO 140                                                          CALPLT    107
      C  *                                                                     CALPLT    108
      C  ***    READ Y-AXIS LABEL.                                             CALPLT    109
      C  *                                                                     CALPLT    110
      30    READ(NLIST,1010) LABELY                                            CALPLT    111
            GO TO 140                                                          CALPLT    112
      C  *                                                                     CALPLT    113
      C  ***    READ LEGEND TITLE.                                             CALPLT    114
      C  *                                                                     CALPLT    115
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 40     READ(NLIST,1010) (TITLE(K),K=1,4)                                    CALPLT   116
        IF(NPRNT.GT.0) WRITE(6,2010) (TITLE(K),K=1,4)                        CALPLT   117
        NC        = 40                                                       CALPLT   118
        NL        = 1                                                        CALPLT   119
        X         = XLEGND                                                   CALPLT   120
        Y         = YLEGND                                                   CALPLT   121
        YLEGND    = YLEGND - 0.25                                            CALPLT   122
        GO TO 110                                                            CALPLT   123
C   *                                                                        CALPLT   124
C   ***     READ AND PRODUCE PAGE TITLE.                                     CALPLT   125
C   *                                                                        CALPLT   126
 50     READ(NLIST,1020) X,Y                                                 CALPLT   127
 1020   FORMAT(2F10.0)                                                       CALPLT   128
        READ(NLIST,1010) TITLE                                               CALPLT   129
        NC        = 80                                                       CALPLT   130
        NL        = 4                                                        CALPLT   131
        IF(NPRNT.LE.0) GO TO 110                                             CALPLT   132
        WRITE(6,2020) X,Y                                                    CALPLT   133
 2020   FORMAT(5X,2F10.4)                                                    CALPLT   134
        WRITE(6,2010) TITLE                                                  CALPLT   135
C   *                                                                        CALPLT   136
C   ***     PRODUCE TITLES ON CALCOMP PLOTTER.                               CALPLT   137
C   *                                                                        CALPLT   138
 110    Y         = Y + 0.25                                                 CALPLT   139
        DO 130 K=1,NL                                                        CALPLT   140
        Y         = Y - 0.25                                                 CALPLT   141
        CALL ROTATE(X,Y,ANGLE,-1,XR,YR)                                      CALPLT   142
 120    L         = 8*(K - 1) + 1                                            CALPLT   143
        CALL SYMBOL(XR,YR,0.1,TITLE(L),ANGLE,NC)                             CALPLT   144
 130    CONTINUE                                                             CALPLT   145
 140    CONTINUE                                                             CALPLT   146
        IF(NPRNT.LE.0) GO TO 150                                             CALPLT   147
C   *                                                                        CALPLT   148
C   ***     PRODUCE REQUESTED PRINT.                                         CALPLT   149
C   *                                                                        CALPLT   150
        WRITE(6,2030) NCURVS,XPLOT,YPLOT,XLEGND,YLEGND,ANGLE                 CALPLT   151
 2030   FORMAT(5X,I5,5X,5F10.4)                                              CALPLT   152
        WRITE(6,2040) LABELX,LNGTHX,STARTX,DELX,XORG                         CALPLT   153
 2040   FORMAT(5X,4A10,4F10.4)                                               CALPLT   154
        WRITE(6,2040) LABELY,LNGTHY,STARTY,DELY,YORG                         CALPLT   155
C                                                                          C CALPLT   156
C**************            DRAW AND LABEL X AXIS            **************C CALPLT   157
C                                                                          C CALPLT   158
 150    Y         = -(STARTY - YORG)/DELY                                    CALPLT   159
        XDUM      = STARTY + DELY*LNGTHY                                     CALPLT   160
        IF(STARTY.LT.YORG.AND.XDUM.LT.YORG) Y = 0.0                          CALPLT   161
        IF(STARTY.GT.YORG.AND.XDUM.GT.YORG) Y = 0.0                          CALPLT   162
        NC        = -4                                                       CALPLT   163
        XDUM      = 0.5*LNGTHY                                               CALPLT   164
        IF(Y.GT.XDUM) NC = 4                                                 CALPLT   165
        X         = 0.0                                                      CALPLT   166
        CALL ROTATE(X,Y,ANGLE,-1,XR,YR)                                      CALPLT   167
        CALL AXIS(XR,YR,BLANK,NC,LNGTHX,ANGLE,STARTX,DELX)                   CALPLT   168
        X         = 0.5*LNGTHX - 2.0                                         CALPLT   169
        Y         = -0.4                                                     CALPLT   170
        CALL ROTATE(X,Y,ANGLE,-1,XR,YR)                                      CALPLT   171
        CALL SYMBOL(XR,YR,0.1,LABELX,ANGLE,40)                               CALPLT   172
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      C                                                                 C CALPLT 173
      C**************       DRAW AND LAPEL Y AXIS         **************C CALPLT 174
      C                                                                 C CALPLT 175
            Y       = -(STARTX - XORG)/DELX                               CALPLT 176
            XDUM    = STARTX + DELX*LNGTHX                                CALPLT 177
            IF(STARTX.LT.XORG.AND.XDUM.LT.XORG) X = 0.0                   CALPLT 178
            IF(STARTX.GT.XORG.AND.XDUM.GT.XORG) X = 0.0                   CALPLT 179
            NC      = 40                                                  CALPLT 180
            XDUM    = 0.5*LNGTHX                                          CALPLT 181
            IF(X.GT.XDUM) NC = -40                                        CALPLT 182
            Y       = 0.0                                                 CALPLT 183
            CALL ROTATE(X,Y,ANGLE,-1,XR,YR)                               CALPLT 184
            CALL AXIS(XR,YR,LABELY,NC,LNGTHY,ANGLE+90.0,STARTY,DELY)      CALPLT 185
      C                                                                 C CALPLT 186
      C**************       BEGIN LOOP FOR EACH CURVE ON PLOT   **********C CALPLT 187
      C                                                                 C CALPLT 188
            DO 300 J=1,NCURVS                                             CALPLT 189
            RFAD(NLIST,CURVE)                                             CALPLT 190
            RFAD(NLIST,1030) LSTYLE,(TITLE(K),K=1,4)                      CALPLT 191
       1030 FORMAT(O6,4X,4A10)                                            CALPLT 192
            IF(NPRNT.GT.O) WRITE(6,2050) (TITLE(K),K=1,4),NDATA,NCOLX,NCOLY, CALPLT 193
           1                         NSYM,LINTYP,DASH,SCALEX,SCALEY,LSTYLE CALPLT 194
       2050 FORMAT(5X,4A10,5I3,F5.3,2F7.4,O6)                             CALPLT 195
            DO 190 K=1,4                                                  CALPLT 196
            IF(TITLE(K).NE.BLANK) GO TO 200                               CALPLT 197
        190 CONTINUE                                                      CALPLT 198
            GO TO 240                                                     CALPLT 199
        200 IF(LINTYP.LT.0) GO TO 220                                     CALPLT 200
      C *                                                                 CALPLT 201
      C ***     DRAW LINE FOR LEGEND.                                     CALPLT 202
      C *                                                                 CALPLT 203
            X          = XLEGND                                           CALPLT 204
            XX         = X + 1.0                                          CALPLT 205
            Y          = YLEGND + 0.05                                    CALPLT 206
            YY         = Y                                                CALPLT 207
            CALL ROTATE(X,Y,ANGLE,-1,XR,YR)                               CALPLT 208
            CALL PLOT(XR,YR,3)                                            CALPLT 209
            CALL ROTATE(XX,YY,ANGLE,-1,XR,YR)                             CALPLT 210
            IF(LSTYLE.GE.LSMAX.OR.LSTYLE.LE.0) CALL PLOT(XR,YR,2)         CALPLT 211
            IF(LSTYLE.LT.LSMAX.AND.LSTYLE.GT.0) CALL DASPLT(XR,YR,DASH,LSTYLE) CALPLT 212
        220 IF(LINTYP.EQ.0.OR.NSYM.EQ.99) GO TO 230                       CALPLT 213
      C *                                                                 CALPLT 214
      C ***     DRAW SYMBOL FOR LEGEND.                                   CALPLT 215
      C *                                                                 CALPLT 216
            X          = XLEGND + 0.5                                     CALPLT 217
            Y          = YLEGND + 0.05                                    CALPLT 218
            CALL ROTATE(X,Y,ANGLE,-1,XR,YR)                               CALPLT 219
            CALL SYMBOL(XR,YR,0.1,NSYM,ANGLE,-1)                          CALPLT 220
      C *                                                                 CALPLT 221
      C ***     WRITE LEGEND NOTATION.                                    CALPLT 222
      C *                                                                 CALPLT 223
        230 X          = XLEGND + 1.1                                     CALPLT 224
            Y          = YLEGND                                           CALPLT 225
            CALL ROTATE(X,Y,ANGLE,-1,XR,YR)                               CALPLT 226
            CALL SYMBOL(XR,YR,0.1,TITLE,ANGLE,40)                         CALPLT 227
            YLEGND     = YLEGND - 0.25                                    CALPLT 228
      C *                                                                 CALPLT 229
      C  ***     READ AND PLOT DATA.                                            CALPLT  230
      C  *                                                                      CALPLT  231
  240 REWIND NDATA                                                              CALPLT  232
      READ(NDATA) K,NCOL,L                                                      CALPLT  233
      IF(L.EQ.0) GO TO 250                                                      CALPLT  234
      READ(NDATA) (ROW(L),L=1,NCOL)                                             CALPLT  235
      K        = IFIX(ROW(NCOLX) + 0.001)                                       CALPLT  236
  250 IF(SCALEX.EQ.0.0) SCALEX = 1.0                                            CALPLT  237
      IF(SCALEY.EQ.0.0) SCALEY = 1.0                                            CALPLT  238
      IF(SCALXX.EQ.0.0) SCALXX = SCALEX                                         CALPLT  239
      IF(SCALYY.EQ.0.0) SCALYY = SCALEY                                         CALPLT  240
      NN       = IABS(LINTYP)                                                   CALPLT  241
      DO 300 L=1,K                                                              CALPLT  242
      READ(NDATA) (ROW(LL),LL=1,NCOL)                                           CALPLT  243
      NN       = NN + 1                                                         CALPLT  244
      IF(NN.LT.IABS(LINTYP).AND.LINTYP.LT.0) GO TO 300                          CALPLT  245
      X        = SCALEX*ROW(NCOLX)                                              CALPLT  246
      Y        = SCALEY*ROW(NCOLY)                                              CALPLT  247
      XX       = (X - STARTX)/DELX                                              CALPLT  248
      YY       = (Y - STARTY)/DELY                                              CALPLT  249
      CALL ROTATE(XX,YY,ANGLE,-1,XR,YR)                                         CALPLT  250
  260 IF(LINTYP.LT.0) GO TO 270                                                 CALPLT  251
      IF(L.EQ.1.AND.LINTYP.GT.0) GO TO 270                                      CALPLT  252
      IF(L.EQ.1.AND.LINTYP.EQ.0) GO TO 290                                      CALPLT  253
      C  ***     PRODUCE LINE SEGMENT.                                          CALPLT  254
      IF(LSTYLE.GE.LSMAX.OR.LSTYLE.LE.0) CALL PLOT(XR,YR,2)                     CALPLT  255
      IF(LSTYLE.LT.LSMAX.AND.LSTYLE.GT.0) CALL DASPLT(XR,YR,DASH,LSTYLE) CALPLT  256
      IF(LINTYP.EQ.0.OR.NN.LT.IABS(LINTYP)) GO TO 300                           CALPLT  257
      C  ***     PRODUCE SYMBOL.                                                CALPLT  258
  270 IF(NSYM.EQ.99) GO TO 280                                                  CALPLT  259
      CALL SYMBOL(XR,YR,0.1,NSYM,ANGLE,-1)                                      CALPLT  260
      GO TO 290                                                                 CALPLT  261
  280 CONTINUE                                                                  CALPLT  262
      CALL ELLIPSE(X,Y,ROW(NCX),ROW(NCY),ROW(NCXY),ANGLE,STARTX,DELX,           CALPLT  263
     *              STARTY,DELY,SCALXX,SCALYY)                                  CALPLT  264
  290 CALL PLOT(XR,YR,3)                                                        CALPLT  265
      NN       = 0                                                              CALPLT  266
  300 CONTINUE                                                                  CALPLT  267
      WRITE(6,2060) I                                                           CALPLT  268
 2060 FORMAT(5X,21HCOMPLETED PLOT NUMBER,I5)                                    CALPLT  269
  310 CONTINUE                                                                  CALPLT  270
      CALL PLOT(XEXIT,YEXIT,999)                                                CALPLT  271
      RETURN                                                                    CALPLT  272
      END                                                                       CALPLT  273
      SUBROUTINE DASPLT(XPAGE,YPAGE,DASH,ISTYLE)                      DASPLT     2
C     ORIGINAL ROUTINE BY CANTRELL AND FRENCH FOR USE ON CDC3300      DASPLT     3
C     MODIFIED TO 360 VERSION WITH HEXADECIMAL INPUT BY               DASPLT     4
C     E. E. SMART, AERODYNAMICS ENGINEER                              DASPLT     5
C     3-2-72                                                          DASPLT     6
C* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * DASPLT     7
C*                                                                  * DASPLT     8
C*         DASHPLOT PLOTS A LINE FROM THE PRESENT PEN POSITION TO   * DASPLT     9
C*         THE LOCATION DEFINED BY THE FIRST AND SECOND ARGUMENTS   * DASPLT    10
C*         WITH PEN UP AND DOWN COMMANDS CONTROLLED BY THE VALUES   * DASPLT    11
C*         OF THE THIRD AND FOURTH ARGUMENTS.                       * DASPLT    12
C*                                                                  * DASPLT    13
C*         CALLING ARGUMENTS                                        * DASPLT    14
C*                                                                  * DASPLT    15
C*            XPAGE,     = X,Y COORDINATES OF THE TERMINAL POSI-     * DASPLT    16
C*            YPAGE        TION TO WHICH THE PEN IS MOVED, IN       * DASPLT    17
C*                         INCHES FROM THE CURRENT ORIGIN (INPUT)   * DASPLT    18
C*                                                                  * DASPLT    19
C*            DASHSIZE = BASIC PLOTTING INCREMENT IN INCHES. A      * DASPLT    20
C*                         VALUE OF ZERO IS DEFAULTED TO 0.1        * DASPLT    21
C*                         INCH. A VALUE OF LESS THAN ZERO          * DASPLT    22
C*                         CAUSES RESIDUE FROM A PREVIOUS           * DASPLT    23
C*                         CALL (SEE BELOW) TO BE IGNORED           * DASPLT    24
C*                         AND THE ABSOLUTE VALUE IS RE-            * DASPLT    25
C*                         TURNED TO THE CALLING PROGRAM.           * DASPLT    26
C*                         (INPUT/OUTPUT)                           * DASPLT    27
C*                                                                  * DASPLT    28
C*            ISTYLE     = BIT PATTERN CONTROLLING PEN UP AND DOWN   * DASPLT    29
C*                         COMMANDS. IF THE HIGH ORDER BIT IS SET,  * DASPLT    30
C*                         THE PEN IS DOWN FOR THE PLOTTING OF THE  * DASPLT    31
C*                         NEXT INCREMENT. IF THE HIGH ORDER BIT    * DASPLT    32
C*                         IS NOT SET, THE PEN IS UP FOR THE PLOT-  * DASPLT    33
C*                         TING OF THE NEXT INCREMENT. FOLLOWING    * DASPLT    34
C*                         THE PLOTTING OF EACH INCREMENT, THE BIT  * DASPLT    35
C*                         PATTERN IS SHIFTED LEFT (END AROUND) TO  * DASPLT    36
C*                         POSITION THE NEXT BIT FOR CONTROLLING    * DASPLT    37
C*                         THE PEN. THE CURRENT CONFIGURATION OF    * DASPLT    38
C*                         THE PATTERN IS RETURNED TO THE CALLING   * DASPLT    39
C*                         PROGRAM. A VALUE OF ZERO IS HANDLED AS   * DASPLT    40
C*                         IF ALL BITS WERE SET. (INPUT/OUTPUT)     * DASPLT    41
C*                                                                  * DASPLT    42
C*                                                                  * DASPLT    43
C*         WHEN THE PLOTTING OF THE LINE HAS BEEN COMPLETED, IF A   * DASPLT    44
C*         PORTION OF AN INCREMENT REMAINS TO BE PLOTTED, THE RES-  * DASPLT    45
C*         IDUE IS SAVED. IF THE NEXT CALL TO DASHPLOT HAS THE      * DASPLT    46
C*         SAME VALUE OF ISTYLE AS THAT RETURNED TO THE CALLING     * DASPLT    47
C*         PROGRAM, THE LENGTH OF THE RESIDUE IS FIRST PLOTTED BE-  * DASPLT    48
C*         FORE PLOTTING OF COMPLETE INTERVALS RESUMES. THUS, A     * DASPLT    49
C*         LINE PATTERN MAY BE MAINTAINED ACROSS A SERIES OF LINE   * DASPLT    50
C*         SEGMENTS.                                                * DASPLT    51
C*                                                                  * DASPLT    52
C*         IF THE IAPRT PARAMETER IS USED IN THE CALL TO PLOTS,     * DASPLT    53
C*         THE NEGATIVE FRAME NUMBER IS RETURNED IN THE A-REGISTER  * DASPLT    54
C*         WHEN THE FILE IS FULL. IF THE FILE IS NOT FULL, A POSI-  * DASPLT    55
C*         TIVE NUMBER IS RETURNED.                                 * DASPLT    56
C*                                                                  * DASPLT    57
C*         CAUTION SHOULD BE EXERCISED IN THE USE OF THE DASHSIZE   * DASPLT    58
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      C*.      AND ISTYLE ARGUMENTS. NUPEPIC CONSTANTS SHOULD NOT BE       * DASPLT     59
      C*       USED SINCE THE VALUES MAY BF CHANGED BEFORE THE RETURN      * DASPLT     60
      C*       IS MADE.                                                    * DASPLT     61
      C*                                                                   * DASPLT     62
      C* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * DASPLT     63
            INTEGER PNTEST,SHIFT                                             DASPLT     64
            DATA(PNTEST=100000B),(SHIFT=177777B)                             DASPLT     65
      C                                                                      DASPLT     66
      C FIRST EXECUTABLE STATEMENT                                           DASPLT     67
      C                                                                      DASPLT     68
      C SET DEFAULT VALUE FOR INCREMENT SIZE IF NECESSAPY                    DASPLT     69
      C                                                                      DASPLT     70
          1 SIZE=DASH                                                        DASPLT     71
            IF(SIZE) 5,10,20                                                 DASPLT     72
      C                                                                      DASPLT     73
      C   INHIBIT RESIDUE PLOTTING                                           DASPLT     74
      C                                                                      DASPLT     75
          5 DASH = -SIZE                                                     DASPLT     76
            JSTYLE=0                                                         DASPLT     77
            GO TO 1                                                          DASPLT     78
         10 SIZE=.1                                                          DASPLT     79
      C                                                                      DASPLT     80
      C DETERPINE IF A PREVIOUS BIT PATTERN IS TO BE CONTINUED               DASPLT     81
      C                                                                      DASPLT     82
         20 IF(ISTYLE-JSTYLE) 30,40,30                                       DASPLT     83
      C                                                                      DASPLT     84
      C START A NEW BIT PATTERN                                              DASPLT     85
      C                                                                      DASPLT     86
         30 JSTYLE=ISTYLE                                                    DASPLT     87
            GO TO 50                                                         DASPLT     88
      C                                                                      DASPLT     89
      C CONTINUE A BIT PATTERN, DETERPINE IF THE PREVIOUS PLOTTING LEFT A POR- DASPLT    90
      C TION OF AN INTERVAL REMAINING TO BE PLOTTED                          DASPLT     91
      C                                                                      DASPLT     92
         40 IF(RESIDU ) 60,50,60                                             DASPLT     93
      C                                                                      DASPLT     94
      C SET THE RESIDUE TO A FULL PLOTTING INTEPVAL                          DASPLT     95
      C                                                                      DASPLT     96
         50 RESIDU =SIZE                                                     DASPLT     97
      C                                                                      DASPLT     98
      C FIND THE PRESENT PEN LOCATION                                        DASPLT     99
      C                                                                      DASPLT    100
         60 CALL WHERE(X,Y,XDIFF)                                            DASPLT    101
      C                                                                      DASPLT    102
      C FIND THE OVERALL DISTANCES REQUESTED FOR PLOTTING                    DASPLT    103
      C                                                                      DASPLT    104
      C   HORIZONTAL                                                         DASPLT    105
      C                                                                      DASPLT    106
            XDIFF=XPAGE-X                                                    DASPLT    107
      C                                                                      DASPLT    108
      C   VERTICAL                                                           DASPLT    109
      C                                                                      DASPLT    110
            YDIFF=YPAGE-Y                                                    DASPLT    111
      C                                                                      DASPLT    112
      C   SLANT                                                              DASPLT    113
      C                                                                      DASPLT    114
            TOTAL=SCRT(XDIFF*XDIFF+YDIFF*YDIFF)                              DASPLT    115
      C                                                                 DASPLT 116
      C   ELIMINATE NULL LINE REQUESTS                                  DASPLT 117
      C                                                                 DASPLT 118
          IF(TOTAL) 180,180,70                                          DASPLT 119
      C                                                                 DASPLT 120
      C CALCULATE ANGLE FUNCTIONS                                       DASPLT 121
      C                                                                 DASPLT 122
       70 COSINE=XDIFF/TOTAL                                            DASPLT 123
          SINE=YDIFF/TOTAL                                              DASPLT 124
      C                                                                 DASPLT 125
      C CALCULATE COORDINATE DISTANCES EQUIVALENT TO THE INCREMENT DISTANCE DASPLT 126
      C ALONG THE LINE                                                  DASPLT 127
      C                                                                 DASPLT 128
      C   HORIZONTAL                                                    DASPLT 129
      C                                                                 DASPLT 130
          DELX=SIZE*COSINE                                              DASPLT 131
      C                                                                 DASPLT 132
      C   VERTICAL                                                      DASPLT 133
      C                                                                 DASPLT 134
          DELY=SIZE*SINE                                                DASPLT 135
      C                                                                 DASPLT 136
      C DETERMINE THE PEN SETTING                                       DASPLT 137
      C                                                                 DASPLT 138
       80   CONTINUE                                                    DASPLT 139
          IPEN = 3                                                      DASPLT 140
          IF(JSTYLE.GE.PNTEST) IPEN = 2                                 DASPLT 141
      C DETERMINE IF THE FULL LENGTH OF THE RESIDUE MAY BE PLOTTED      DASPLT 142
      C                                                                 DASPLT 143
      110 IF(RESIDU -TOTAL) 120,160,170                                 DASPLT 144
      C                                                                 DASPLT 145
      C THE ENTIRE RESIDUE MAY BE PLOTTED, DISTINGUISH BETWEEN A FULL SIZE IN- DASPLT 146
      C CREMENT AND RESIDUE FROM A PREVIOUS CALL                        DASPLT 147
      C                                                                 DASPLT 148
      120 IF(RESIDU -SIZE) 130,140,140                                  DASPLT 149
      C                                                                 DASPLT 150
      C PLOT THE RESIDUE FROM A PREVIOUS CALL                           DASPLT 151
      C                                                                 DASPLT 152
      C   CALCULATE THE NEW PEN POSITION                                DASPLT 153
      C                                                                 DASPLT 154
      C   HORIZONTAL                                                    DASPLT 155
      130 X=X+RESIDU *COSINE                                            DASPLT 156
      C                                                                 DASPLT 157
      C                                                                 DASPLT 158
      C                                                                 DASPLT 159
      C     VERTICAL                                                    DASPLT 160
          Y=Y+RESIDU *SINE                                              DASPLT 161
      C                                                                 DASPLT 162
      C   CALCULATE THE DISTANCE REMAINING TO BE PLOTTED                DASPLT 163
      C                                                                 DASPLT 164
          TOTAL=TOTAL-RESIDU                                            DASPLT 165
      C                                                                 DASPLT 166
      C   ENABLE FUTURE PLOTTING OF THE FULL INCREMENT LENGTH           DASPLT 167
      C                                                                 DASPLT 168
          RESIDU =SIZE                                                  DASPLT 169
          GO TO 150                                                     DASPLT 170
      C                                                                 DASPLT 171
      C PLOT A FULL INCREMENT LENGTH                                    DASPLT 172
      C                                                                   DASPLT   173
      C   CALCULATE THE NEW PEN POSITION                                  DASPLT   174
      C                                                                   DASPLT   175
      C     HORIZONTAL                                                    DASPLT   176
      C                                                                   DASPLT   177
       140 X=X+DELX                                                       DASPLT   178
      C                                                                   DASPLT   179
      C     VERTICAL                                                      DASPLT   180
      C                                                                   DASPLT   181
          Y=Y+DELY                                                        DASPLT   182
      C                                                                   DASPLT   183
      C   CALCULATE THE DISTANCE REMAINING TO BE PLOTTED                  DASPLT   184
      C                                                                   DASPLT   185
          TOTAL=TOTAL-RESIDU                                              DASPLT   186
      C                                                                   DASPLT   187
      C MOVE THE NEXT BIT IN THE PATTERN INTO CONTROL POSITION             DASPLT   188
      C                                                                   DASPLT   189
       150  JSTYLE = JSTYLE * 2                                           DASPLT   190
          IF(JSTYLE.GT.SHIFT ) JSTYLE = JSTYLE - SHIFT                    DASPLT   191
      C                                                                   DASPLT   192
      C PLOT THE NEXT SEGMENT                                             DASPLT   193
      C                                                                   DASPLT   194
          CALL PLOT(X,Y,IPEN)                                             DASPLT   195
          GO TO 80                                                        DASPLT   196
      C                                                                   DASPLT   197
      C EXACTLY ONE INCREMENT REMAINS TO BE PLOTTED, MOVE THE NEXT BIT IN THE DASPLT   198
      C PATTERN INTO CONTROL POSITION                                     DASPLT   199
      C                                                                   DASPLT   200
       160  JSTYLE = JSTYLE * 2                                           DASPLT   201
          IF(JSTYLE.GT.SHIFT ) JSTYLE = JSTYLE - SHIFT                    DASPLT   202
      C                                                                   DASPLT   203
      C THE LAST SEGMENT OF THE LINE IS TO BE PLOTTED, CALCULATE THE RESIDUE DASPLT   204
      C                                                                   DASPLT   205
       170 RESIDU =RESIDU -TOTAL                                          DASPLT   206
      C                                                                   DASPLT   207
      C PLOT THE FINAL SEGMENT AND SET THE FUNCTION VALUE                  DASPLT   208
      C                                                                   DASPLT   209
          CALL PLOT(XPAGE,YPAGE,IPEN  )                                   DASPLT   210
      C                                                                   DASPLT   211
      C RETURN THE CURRENT BIT PATTERN TO THE CALLER                       DASPLT   212
      C                                                                   DASPLT   213
          ISTYLE=JSTYLE                                                   DASPLT   214
      C                                                                   DASPLT   215
      C RETURN                                                            DASPLT   216
      C                                                                   DASPLT   217
       180 RETURN                                                         DASPLT   218
          END                                                             DASPLT   219
          SUBROUTINE DEQU                                                     DEQU       2
      C   ******************************************************************* DEQU       3
      C   ***                                                                 DEQU       4
      C   ***     ROUTINE TO HANDLE SYSTEM DIFFERENTIAL EQUATIONS FOR MEANS.  DEQU       5
      C   ***                                                                 DEQU       6
      C   ******************************************************************* DEQU       7
      C   *                                                                   R          2
      C   ***     R ARRAY SEGMENT 1 - INTEGRATION VARIABLES.                  R          3
      C   *                                                                   R          4
          COMMON TIME,TO,DTIME,DTOUT,DTOUT2,TMAX                              R          5
      C   *                                                                   R          6
      C   ***     R ARRAY SEGMENT 2 - DERIVATIVES.                            R          7
      C   *                                                                   R          8
          COMMON UDOT,WDOT,QDOT,TDOT,XAPPDOT,ZAPPDOT,DFRPMD,XSPDOT,           R          9
         A       ZSPDOT,TSPDOT,                                               R         10
         B       VDOT,PBDOT,RBDOT,YAPPDOT,PHIDOT,PSIDOT,YSPDOT                R         11
      C   *                                                                   R         12
      C   ***     R ARRAY SEGMENT 3 - STATE VARIABLES.                        R         13
      C   *                                                                   R         14
          COMMON UB,WB,QB,THETA,XAPP,ZAPP,DFRPM,XSP,ZSP,THETAS,               R         15
         A       VB,PB,RB,YAPP,PHI,PSI,YSP                                    R         16
      C   *                                                                   R         17
      C   ***     R ARRAY SEGMENT 4 - REF. VALUES FOR LOCAL LINEARIZATION.    R         18
      C   *                                                                   R         19
          COMMON UO,WO,QO,THETAO,XAPPO,ZAPPO,XO,ZO,MO,UBASO,WBASO,WASDO,      R         20
         A       THETAAO,PSIAO,PHIAO,RCDO,VO,PO,RO,YAPPO,PHIO,PSIO,YO,LO,     R         21
         B       NO,VBASO                                                     R         22
          REAL   MO,LO,NO                                                     R         23
      C   *                                                                   R         24
      C   ***     R ARRAY SEGMENT 5 - INPUT FORCES AND MOMENTS.               R         25
      C   *                                                                   R         26
          COMMON SUMFXO,SUMFZO,SUMMO,SUMFX,DFX,SUMFZ,DFZ,SUMM,DM,             R         27
         A       SUMFYO,SUMLO,SUMNO,SUMFY,DFY,SUML,DL,SUMN,DN                 R         28
      C   *                                                                   R         29
      C   ***     R ARRAY SEGMENT 6 - GEOMETRY.                               R         30
      C   *                                                                   R         31
          COMMON WEIGHT,G,IX,IY,IZ,IXZ,LM,WM,LTDM,LS,LTDS                     R         32
          REAL   G,IX,IY,IZ,IXZ,LM,LTDM,LS,LTDS                               R         33
      C   *                                                                   R         34
      C   ***     R ARRAY SEGMENT 7 - CONSTANTS.                              R         35
      C   *                                                                   R         36
          COMMON  OMEGAU,OMEGAW,KU,KW,KFRPM,KCDN,TAUENG,TAUCDN,TAUD,          R         37
         1         KDEU,KDEW,KDEQ,KDET,KDEX,KDEZ,KDEN,KDEDE,KDEDT,            R         38
         2         KDTU,KDTW,KDTQ,KDTT,KDTX,KDTZ,KDTN,KDTDE,KDTDT,            R         39
         3        OMEGAV,KV,TAUA,K1,K2,KY,B1,B2,TL1,TL2                       R         40
          REAL  KU,KW,KFRPM,KCDN,                                             R         41
         1      KDEU,KDEW,KDEQ,KDET,KDEX,KDEZ,KDEN,KDEDE,KDEDT,               R         42
         2      KDTU,KDTW,KDTQ,KDTT,KDTX,KDTZ,KDTN,KDTDE,KDTDT,               R         43
         3       K1,K2,KY,KV                                                  R         44
      C   *                                                                   R         45
      C   ***     R ARRAY SEGMENT 8 - WIND, ALTITUDE, AIRSPEED AND AIRWAKE.   R         46
      C   *                                                                   R         47
          COMMON ALT,VAIR,UBAS,VBAS,WBAS,ALPHA,BETA,DUM1,DUM2,V5,PSI5,X1DWS,  R         48
         A       Y1DWS,VAMB,PSIAMB,X1DWA,Y1DWA,Z1DWA,VWOD,PSIWOD,PSI3,PSISP,  R         49
         B       PSIS,DX45,DY45,DZ45,XM,YM,ZM,PSIA,THETAA,PHIA,SIGMAVX,       R         50
         C       SIGMAVY,SIGMAVZ,VXAW,VYAW,VZAW,UWIND,UMEAN,UR,UAW,VWIND,     R         51
         D       VMEAN,VR,VAW,WWIND,WMEAN,WR,WAW,WNSF,PSISS,PSISC,PSIST,TS1,  R         52
      E       IS2,IS3,IS4,IS5,IR1,DXM145,DXM245,DYM145,DYM245,ZGSP,          R          53
      F       ZRIASP                                                         R          54
C  *                                                                         R          55
C  ***    R ARRAY SEGMENT 9 - OPEN LOOP PARAMETERS.                          R          56
C  *                                                                         R          57
      COMMON THETAC,DFRPMOL,DCONOL,DEOL,GAMMAGS,RANGE,VAIRC,                 R          58
     1        DAOL,DROL                                                      R          59
C  *                                                                         R          60
C  ***    R ARRAY SEGMENT 10 - AERO DATA.                                    R          61
C  *                                                                         R          62
      COMMON XU,XW,XO,XFRPM,XCON,XPDIGV,XDE,ZU,ZW,ZQ,ZFRPM,ZCDN,ZPDIGV,      R          63
     A        ZDE,MU,MW,MWDOT,MQ,MFRPM,MCON,MPDIGV,MDE,                      R          64
     B         YV,YP,YR,YDA,YDR,LV,LP,LR,LDA,LDR,NV,NP,NR,                   R          65
     C         NDA,NDR                                                       R          66
      REAL   MU,MW,MWDOT,MQ,MFRPM,MCON,MPDIGV,MDE                            R          67
      REAL  LV,LP,LR,LDA,LDR,NV,NP,NR,NDA,NDR                                R          68
C  *                                                                         R          69
C  ***    R ARRAY SEGMENT 11                                                 R          70
C  *                                                                         R          71
      COMMON  RC,RCD,XAPCOM,ERRX,ERRU,       ERRZ,ERRW, ETHETA,              R          72
     1         ERY,ERPHI,ERPSI,YCOM,PHICOM,PSICOM                            R          73
C  *                                                                         R          74
C  ***    R ARRAY SEGMENT 12 - CONTROLS.                                     R          75
C  *                                                                         R          76
      COMMON  DE,DT,DCDN,DED,DTD,DCDND.                                      R          77
     1         DA,DR,DAP,DRP,DA1,DA2,DR1,DR2,DA1D,DA2D,DR1D,DR2D             R          78
C  *                                                                         R          79
C  ***    R ARRAY SEGMENT 13 - SPEED TABLE FOR AERO TABLE LOOKUPS.           R          80
C  *                                                                         R          81
      COMMON TABV1(6)                                                        R          62
C  *                                                                         R          83
C  ***    R ARRAY SEGMENT 14 -  TIME TABLE FOR OPEN LOOP COMMAND TABLE L     R          84
C  *                                                                         R          85
      COMMON TABV2(10)                                                       R          86
C  *                                                                         R          87
C  ***    R ARRAY SEGMENT 15 - UNUSED                                        R          88
C  *                                                                         R          89
C  *                                                                         R          90
C  ***    R ARRAY SEGMENT 16 - GDF RELATED STUFF                             R          91
C  *                                                                         R          92
      COMMON SIGDAP, SIGDRP, SIGDA, SIGDR, GAINDA, GAINDR                    R          93
C  *                                                                         R          94
C  ***    R ARRAY SEGMENT 17 - SHIP MOTION                                   R          95
C  *                                                                         R          96
      COMMON KXS,ZETAXS,WNXS,KZS,ZETAZS,WNZS,KTS,ZETATS,WNTS,                R          97
     1        KYS,ZETAYS,WNYS,KRS,ZETARS,WNRS,KPS,ZETAPS,WNPS,TAUPRT         R          98
      REAL KXS,KZS,KTS,KYS,KRS,KPS                                           R          99
C  *                                                                         R         100
C  ***    R ARRAY SEGMENTS 20-23 - OPEN LOOP COMMAND TABLES.                 R         101
C  *                                                                         R         102
      COMMON TABTC(10)                                                       R         103
      COMMON TRPMCL(10)                                                      R         104
      COMMON TCDNOL(10)                                                      R         105
      COMMON TDECL(10)                                                       R         106
C  *                                                                         R         107
C  ***    R ARRAY SEGMENTS 24-25                                             R         108
C  *                                                                         R         109
     1        [illegible],VY(1,1),
      COMMON TABR(10)                                                    R       110
      COMMON TABRDOT(10)                                                 R       111
C *                                                                      R       112
C ***     R ARRAY SEGMENTS 27-48 - LONGITUDINAL AERO DATA TABLES         R       113
C *                                                                      F       114
      COMMON TXU(6)                                                      R       115
      COMMON TXW(6)                                                      R       116
      COMMON TXQ(6)                                                      R       117
      COMMON TXRPM(6)                                                    R       118
      COMMON TXCON(6)                                                    R       119
      COMMON TXPIGV(6)                                                   R       120
      COMMON TXDE(6)                                                     R       121
      COMMON TZU(6)                                                      R       122
      COMMON TZW(6)                                                      R       123
      COMMON TZQ(6)                                                      R       124
      COMMON TZRPM(6)                                                    R       125
      COMMON TZCON(6)                                                    R       126
      COMMON TZPIGV(6)                                                   R       127
      COMMON TZDE(6)                                                     R       128
      COMMON TMU(6)                                                      R       129
      COMMON TMW(6)                                                      R       130
      COMMON TMWD(6)                                                     R       131
      COMMON TMQ(6)                                                      R       132
      COMMON TMRPM(6)                                                    R       133
      COMMON TMCON(6)                                                    R       134
      COMMON TMPIGV(6)                                                   R       135
      COMMON TMDE(6)                                                     R       136
C *                                                                      R       137
C ***     R ARRAY SEGMENTS 50-54 - COVARIANCE MATRICIES (DO NOT OVERDIME R       138
C *                                                                      R       139
      COMMON  F(17,17),P(17,17),PDOT(17,17),GM(11,4),QM(4,4)             R       140
C *                                                                      R       141
C ***     R ARRAY SEGMENTS 55-56 - STANDARD DEVIATIONS.                  R       142
C *                                                                      R       143
      COMMON SIGMA(50)                                                   R       144
      COMMON SIGMAXY(50)                                                 R       145
C *                                                                      R       146
C ***     R ARRAY SEGMENTS 57-62 - AIRWAKE TABLES                        R       147
C *                                                                      R       148
      COMMON VXX(5,5,3)                                                  R       149
      COMMON VYY(5,5,3)                                                  R       150
      COMMON VZZ(5,5,3)                                                  R       151
      COMMON SVXX(5,5,3)                                                 R       152
      COMMON SVYY(5,5,3)                                                 R       153
      COMMON SVZZ(5,5,3)                                                 R       154
C *                                                                      R       155
C ***     R ARRAY SEGMENTS 63-80 - OPTIMAL CONTROLLER GAINS              R       156
C *                                                                      R       157
      COMMON    TKDEU(6), TKDEW(6), TKDEQ(6), TKDET(6), TKDEX(6),        R       158
     1          TKDEZ(6), TKDEN(6), TKDEDE(6), TKDEDT(6),                R       159
     2          TKDTU(6), TKDTW(6), TKDTQ(6), TKDTT(6), TKDTX(6),        R       160
     3          TKDTZ(6), TKDTN(6), TKDTDE(6), TKDTDT(6)                 R       161
C *                                                                      R       162
C ***     R ARRAY SEGMENTS 81-106                                        R       163
C *                                                                      R       164
      COMMON F1(6,6),G1(6,4),GAMMA(6,7),A(7,7),B(7,4),M1(1,1),M2(1,1),   R       165
     1  H(1,1),D(1,1),C(4,6),R1(4,4),W(1,1),VU(1,1),VY(1,1),             R       166
     2        VYI(1,1),S(1,1),FE(1,1),CE(1,1),PE(1,1),PFO(1,1),                R       167
     3        KG(1,1),FXHAT(1,1),PXHAT(1,1),PXHATD(1,1),PX(1,1),               R       168
     4        CS(1,1)                                                          R       169
      REAL M1,M2,KG                                                            R       170
C  *                                                                           R       171
C  ***     R ARRAY SEGMENT 107 - MORE OPTIMAL CONTROLLER GAINS (NOISE REL      R       172
C  *                                                                           R       173
      COMMON  DEUR, DEWR, DEVX, DEVXD, DEVZ, DEVZD,                            R       174
     1        DTUR, DTWR, DTVX, DTVXD, DTVZ, DTVZD                             R       175
C  *                                                                           R       176
C  ***     R ARRAY SEGMENTS 108-119                                            R       177
C  *                                                                           R       178
      COMMON  TDEUR(6), TDEWR(6), TDEVX(6), TDEVXD(6), TDEVZ(6),               R       179
     1        TDEVZD(6),  TDTUR(6), TDTWR(6), TDTVX(6), TDTVXD(6),             R       180
     2        TDTVZ(6), TDTVZD(6)                                              R       181
C *                                                                            R       182
C ***      R ARRAY SEGMENTS 120-134 - LAT/DIR AERO DATA TABLES                 R       183
C *                                                                            R       184
      COMMON  TYV(6), TYP(6), TYR(6), TYDA(6), TYDR(6),                        R       185
     1        TLV(6), TLP(6), TLR(6), TLDA(6), TLDR(6),                        R       186
     2        TNV(6), TNP(6), TNR(6), TNDA(6), TNDR(6)                         R       187
C *                                                                            R       188
C ***      R ARRAY SEGMENTS 135-139 - LONG. TERMS RECD FOR LAT/DIR CASE        R       189
C *                                                                            R       190
      COMMON  TABUB(10),TABWB(10),TXAPP(10),TZAPP(10),TXSP(10)                 R       191
C  *                                                                           R       192
C  ***     R ARRAY SEGMENTS 140-143 - TABLES OF NONLINEAR FUNCTIONS            R       193
C  *                                                                           R       194
      COMMON TDAIN(4), TDAOUT(4), TDRIN(4),TDROUT(4)                           R       195
C  ******************************************************************    C R       196
C  *                                                                           I         2
C  ***     I ARRAY SEGMENT 1 - INTEGER VARIABLES.                              I         3
C  *                                                                           I         4
      COMMON/INTEGER/ICEES,NEQU,NSTATES,NPA,NOM,NGM,NPE,NPX,NOAW,NOINIT        I         5
C  *                                                                           I         6
C  ***     I ARRAY SEGMENT 4 - DERIVATIVE INDICES.                             I         7
C  *                                                                           I         8
      COMMON/INTEGER/ INDX1(14)                                                I         9
C  *                                                                           I        10
C  ***     I ARRAY SEGMENT 5 - STATE INDICES.                                  I        11
C  *                                                                           I        12
      COMMON/INTEGER/ INDX2(14)                                                I        13
C  *                                                                           I        14
C  ***     I ARRAY SEGMENT 6 - VARIOUS INDICES.                                I        15
C  *                                                                           I        16
      COMMON/INTEGER/ INDXPD,INDXP,INDXPED,INDXPE,INDXPXD,INDXPX               I        17
C  *****************************************************************     C I        18
C *                                                                            DEQU     10
C ***      DIMENSION STATEMENTS                                                DEQU     11
C *                                                                            DEQU     12
      DIMENSION  CA(17)                                                        DEQU     13
C *                                                                            DEQU     14
C ***      DATA STATEMENTS                                                     DEQU     15
C *                                                                            DEQU     16
C                                                                              DEQU     17
C  *****************         DIFFERENTIAL EQUATIONS          ************      DEQU     18
C                                                                              DEQU     19
C *                                                                     DEQU    20
C ***      LOOK UP VALUES OF REQUIRED LONGITUDINAL PARAMETERS           DEQU    21
C *                                                                     DEQU    22
      IF(NOINIT .LT. 0 .AND. TIME .GT. 0.0) GO TO 5                     DEQU    23
      CALL TLU(TIME,TABV2,10,TABUB,2,UB)                                DEQU    24
      CALL TLU(TIME,TABV2,10,TABTC,1,THETAC)                            DEQU    25
      CALL TLU(TIME,TABV2,10,TXAPP,2,XAPP)                              DEQU    26
      CALL TLU(TIME,TABV2,10,TXSP,1,XSP)                                DEQU    27
    5 CONTINUE                                                          DEQU    28
C *                                                                     DEQU    29
C ***      MISCELLANEOUS CALCULATIONS                                   DEQU    30
C *                                                                     DEQU    31
      THETA =  THETAC                                                   DEQU    32
      ZSP =  0.                                                         DEQU    33
      PP =  PB - PO                                                     DEQU    34
      RP =  RB - RO                                                     DEQU    35
      SINT      = SIN(THETA)                                            DEQU    36
      COST      = COS(THETA)                                            DEQU    37
      TANT      = TAN(THETA)                                            DEQU    38
      SECT      = 1./COS(THETA)                                         DEQU    39
      SPHI      = SIN(PHI)                                              DEQU    40
      CPHI      = COS(PHI)                                              DEQU    41
      SPSI      = SIN(PSI)                                              DEQU    42
      CPSI      = COS(PSI)                                              DEQU    43
C *                                                                     DEQU    44
C ***      ALTITUDE.                                                    DEQU    45
C *                                                                     DEQU    46
      ALT = -ZAPP                                                       DEQU    47
C *                                                                     DEQU    48
C ***      AIRPLANE W.R.T. SHIP, EARTH AXIS.                            DEQU    49
C *                                                                     DEQU    50
      DX45      = XAPP - XSP                                            DEQU    51
      DY45      = YAPP - YSP                                            DEQU    52
      DZ45      = ZAPP - ZSP                                            DEQU    53
C *                                                                     DEQU    54
C ***      AIRPLANE W.R.T. SHIP, SHIP WIND AXIS.                        DEQU    55
C *                                                                     DEQU    56
      XM        = DXM145*DX45 + DXM245*DY45                             DEQU    57
      YM        = DYM145*DX45 + DYM245*DY45                             DEQU    58
      ZM        = DZ45                                                  DEQU    59
C *                                                                     DEQU    60
C ***      EULER ANGLES FOR AIRWAKE MODEL.                              DEQU    61
C *                                                                     DEQU    62
      PSIA      = ASIN(SIN(PSI)*COS(PSI3) - COS(PSI)*SIN(PSI3))         DEQU    63
      THETAA    = THETA                                                 DEQU    64
      PHIA      = PHI                                                   DEQU    65
C *                                                                     DEQU    66
C ***      SHIP AIRWAKE.                                                DEQU    67
C *                                                                     DEQU    68
      IF(NOAW.EQ.0) CALL AIRWAKE                                        DEQU    69
C *                                                                     DEQU    70
C ***      AIRPLANE BODY AXIS COMPONENTS OF AMBIENT WIND.               DEQU    71
C *                                                                     DEQU    72
      UMEAN     = X1DWA*COST*CPSI + Y1DWA*COST*SPSI - Z1DWA*SINT        DEQU    73
      VMEAN     = X1DWA*(SPHI*SINT*CPSI - CPHI*SPSI) +                  DEQU    74
     1            Y1DWA*(SPHI*SINT*SPSI + CPHI*CPSI) +                  DEQU    75
     2            Z1DWA*SPHI*COST)                                      DEQU    76
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      WMEAN   = X1DWA*(CPHI*SINT*CPSI + SPHI*SPSI) +                   DEQU     77
     1          Y1DWA*(CPHI*SINT*SPSI - SPHI*CPSI) +                   DEQU     78
     2          Z1DWA*CPHI*COST                                        DEQU     79
C  *                                                                   DEQU     80
C  ***    WIND.                                                        DEQU     81
C  *                                                                   DEQU     82
      UWIND   = UMEAN + UAW                                            DEQU     83
      VWIND   = VMEAN + VAW                                            DEQU     84
      WWIND   =  WMEAN + WAW                                           DEQU     85
C    INITIALIZE INERTIAL SPEEDS FROM AIRSPEEDS, ONE TIME ONLY.         DEQU     86
      IF(ICEES.EQ.1) UB = UBAS + UWIND                                 DEQU     87
      IF(ICEES.EQ.1) VB = VBAS + VWIND                                 DEQU     88
      IF(ICEES.EQ.1) WB = WBAS + WWIND                                 DEQU     89
C  *                                                                   DEQU     90
C  ***    AIRSPEED.                                                    DEQU     91
C  *                                                                   DEQU     92
      UBAS   = UB - UWIND                                              DEQU     93
      UAS    = UBAS - UBASO                                            DEQU     94
      VBAS   = VB - VWIND                                              DEQU     95
      VAS    = VBAS - VBASO                                            DEQU     96
      WBAS   = WB - WWIND                                              DEQU     97
      WAS    = WBAS - WBASO                                            DEQU     98
      VAIR   = SQRT(UBAS*UBAS + VBAS*VBAS + WBAS*WBAS)                 DEQU     99
      ALPHA = ATAN2(WBAS,UBAS)                                         DEQU    100
      BETA =  ASIN(VBAS/VAIR)                                          DEQU    101
C  *                                                                   DEQU    102
C  ***    LOOK UP AERO AND OPEN LOOP PARAMETERS.                       DEQU    103
C  *                                                                   DEQU    104
      CALL TLU(VAIR,TABV1,6,TYV,15,YV)                                 DEQU    105
      DAOL =  0.                                                       DEQU    106
      DROL =  0.                                                       DEQU    107
C  *                                                                   DEQU    108
C  ***    RANGE FROM SHIP.                                             DEQU    109
C  *                                                                   DEQU    110
      RANGE    = XSP - XAPP                                            DEQU    111
C *                                                                    DEQU    112
C ***     LATERAL POSITION ERROR                                       DEQU    113
C *                                                                    DEQU    114
      YCOM = YSP                                                       DEQU    115
      ERY =  YCOM - YAPP                                               DEQU    116
C *                                                                    DEQU    117
C ***     ROLL ATTITUDE ERROR                                          DEQU    118
C *                                                                    DEQU    119
      PHICOM = KY * ERY                                                DEQU    120
C    ERPHI BIASED BY PHI (TIME=0)                                      DEQU    121
      IF(TIME .EQ. 0.0) PHIBIAS = PHI                                  DEQU    122
      ERPHI = PHICOM - PHI + PHIBIAS                                   DEQU    123
C *                                                                    DEQU    124
C ***     HEADING ERROR                                                DEQU    125
C *                                                                    DEQU    126
      PSICOM =  0.                                                     DEQU    127
      ERPSI  =  PSICOM - PSI                                           DEQU    128
C *                                                                    DEQU    129
C ***     ROLL CONTROL                                                 DEQU    130
C *                                                                    DEQU    131
      DA1D =  -(2./TALD)*DA1 + ERPHI                                   DEQU    132
      DA2D =  (4.*W1/(TAUQ*TALA))*DA1 - (1./TALA)*DA2                  DEQU    133
      1         -(K1/TAUA)*ERPHI                                        DEQU     134
        DAP   =  (4.*TL1*K1/(TAUD*TAUA))*DA1 + (B1-TL1/TAUA)*DA2        DEQU     135
      1         -(K1*TL1/TAUA)*EFPHI                                    DEQU     136
C     CALCULATE SIGMA OF ROLL CONTROL.                                  DEQU     137
        DO 11  I=1,17                                                   DEQU     138
   11 CA(I)= O.                                                         DEQU     139
        CA(4) = K1*TL1/TAUA                                             DEQU     140
        CA(6) = K1*KY*TL1/TAUA                                          DEQU     141
        CA(14)= (4.*K1*TL1)/(TAUD*TAUA)                                 DEQU     142
        CA(15)= B1 - TL1/TAUA                                           DEQU     143
        VAP =  O.                                                       DEQU     144
        CO 12  I=1,17                                                   DEQU     145
        DO 12  J=1,17                                                   DEQU     146
   12 VAR =  VAP  +  CA(I)*CA(J)*P(I,J)                                 DEQU     147
        SIGDAP=  SOPT(VAR)                                              DEQU     148
C     GDF FOR ROLL CONTROL LIMITER                                      DEQU     149
        CALL DESCRIB(1,DAP,SIGDAP,DA,VAR,GAINDA)                        DEQU     150
        SIGDA =  SOFT(VAR)                                              DEQU     151
C *                                                                     DEQU     152
C ***       YAW CONTRCL                                                 DEQU     153
C *                                                                     DEQU     154
        DR1D =  -(2./TAUD)*DR1 + ERPSI                                  DEQU     155
        DR2D =  (4.*K2/(TAUD*TAUA))*DF1 - (1./TAUA)*DR2                 DEQU     156
      1         -(K2/TAUA)*ERPSI                                        DEQU     157
        DRP   =  (4.*TL2*K2/(TAUD*TAUA))*DR1 + (B2-TL2/TAUA)*DR2        DEQU     158
      1         -(K2*TL2/TAUA)*ERPSI                                    DEQU     159
C     CALCULATE SIGMA OF YAW CONTROL.                                   DEQU     160
        DC 21  I=1,17                                                   DEQU     161
   21 CA(I)= O.                                                         DEQU     162
        CA(5) = K2*TL2/TAUA                                             DEQU     163
        CA(16)= (4.*K2*TL2)/(TAUD*TAUA)                                 DEQU     164
        CA(17)= B2 - TL2/TAUA                                           DEQU     165
        VAP =  O.                                                       DEQU     166
        DO 22  I=1,17                                                   DEQU     167
        DC 22  J=1,17                                                   DEQU     168
   22 VAR =  VAR  +  CA(I)*CA(J)*P(I,J)                                 DEQU     169
        SIGDRP=  SQRT(VAR)                                              DEQU     170
C     GDF FOR YAW CONTROL LIMITER                                       DEQU     171
        CALL DESCRIB(2,CRP,SIGDRP,DR,VAR,GAINDR)                        DEQU     172
        SIGDR =  SORT(VAR)                                              DEQU     173
        IF(NOINIT .LT. O) GO TO 200                                     DEQU     174
C  *                                                                    DEQU     175
C  ***     SHIP.                                                        DEQU     176
C  *                                                                    DEQU     177
        YSPDOT =  V5*SIN(PSI5)                                          DEQU     178
C  *                                                                    DEQU     179
C  ***     AIRFRAME.                                                    DEQU     180
C  *                                                                    DEQU     181
        YAPPDOT =  UB*COST*SPSI + VB*(SPHI*SINT*SPSI+CPHI*CPSI)         DEQU     182
      1             + WB*(CPHI*SINT*SPSI-SPHI*CPSI)                     DEQU     183
        D4        = DA + DADL                                           DEQU     184
        D5        = DR + DRCL                                           DEQU     185
        DFY       = YV*VAS + YP*PP + YR*RF                              DEQU     186
        DL        = LV*VAS + LP*PP + LR*RP                              DEQU     187
        DN        = NV*VAS + NP*PP + NR*RP                              DEQU     168
        SUMFY     = YC + DFY + YDA*D4 + YDR*D5                          DEQU     189
        SUML      = LO + DL  + LDA*D4 + LDR*D5                          DEQU     190
```

```
          SUMN     = NO + CN   + NDA*D4 + NDR*D5                                  DEQU      191
          VDOT     = SUMFY + G*COST*SPHI - RP*UB + PB*WB                          DEQU      192
          PBDOT    = SUML                                                         DEQU      193
          RBDOT    = SUMN                                                         DEQU      194
          PHIDOT   = PB + QB*SPHI*TANT + RB*CPHI*TANT                             DEQU      195
          PSIDOT   = (QB*SPHI+RB*CPHI)*SECT                                       DEQU      196
      200 CONTINUE                                                                DEQU      197
C                                                                               C DEQU      198
C**************              UPDATE SUB O VALUES                  **************C DEQU      199
C                                                                               C DEQU      200
          IF(ICEES.EQ.2) GO TO 10                                                 DEQU      201
          UO       = UB                                                           DEQU      202
          VO       = VB                                                           DEQU      203
          WO       = WB                                                           DEQU      204
          PO       = PB                                                           DEQU      205
          RO       = RB                                                           DEQU      206
          PSIO     = PSI                                                          DEQU      207
          THETAO   = THETA                                                        DEQU      208
          PHIO     = PHI                                                          DEQU      209
          XAPPO    = XAPP                                                         DEQU      210
          YAPPO    = YAPP                                                         DEQU      211
          ZAPPO    = ZAPP                                                         DEQU      212
          UBASO    = UBAS                                                         DEQU      213
          VBASO    = VBAS                                                         DEQU      214
          WBASO    = WBAS                                                         DEQU      215
          YO       = YO + DFY                                                     DEQU      216
          LO       = LO + DL                                                      DEQU      217
          NO       = NO + CN                                                      DEQU      218
          THETAAO  = THETAA                                                       DEQU      219
          PSIAO    = PSIA                                                         DEQU      220
          PHIAO    = PHIA                                                         DEQU      221
       10 RETURN                                                                  DEQU      222
          END                                                                     DEQU      223
```

```
              SUBROUTINE DESCRIB(ITAB,BIAS,SIGMA,OMEAN,DVAR,REPRO)                 DESCRIB     2
        C  ************************************************************************ DESCRIB     3
        C  ***                                                                     DESCRIB     4
        C  ***     ROUTINE TO CALCULATE COMPONENTS OF THE DESCRIBING FUNCTION.     DESCRIB     5
        C  ***                                                                     DESCRIB     6
        C  ***     ITAB  - IN  - TABLE NUMBER FOR WHICH D.F. IS TO BE GENERATED.   DESCRIB     7
        C  ***                   TABLE NUMBER IS ESTABLISHED BY THE ORDER OF THE   DESCRIB     8
        C  ***                   CALLS TO TABRD.  THE FIRST NONLINEARITY WORKED    DESCRIB     9
        C  ***                   ON BY TABRD IS NUMBER ONE, SECOND IS NUMBER TWO,  DESCRIB    10
        C  ***                   ETC.                                              DESCRIB    11
        C  ***     BIAS  - IN  - INPUT BIAS (MEAN VALUE).                          DESCRIB    12
        C  ***     SIGMA - IN  - INPUT SIGMA.                                      DESCRIB    13
        C  ***     REPRO - OUT - GAIN ON RANDOM COMPONENT.                         DESCRIB    14
        C  ***     OMEAN - OUT - OUTPUT MEAN.                                      DESCRIB    15
        C  ***     DVAR  - OUT - OUTPUT VARIANCE.                                  DESCRIB    16
        C  ***     REPRO - OUT - GAIN ON RANDOM COMPONENT                          DESCRIB    17
        C  ***                                                                     DESCRIB    18
        C  ************************************************************************ DESCRIB    19
        C  *                                                                       GDF         2
        C  ***     TABLES DECOMPOSED INTO DESCRIBING FUNCTION ELEMENTS.            GDF         3
        C  ***     DIMENSION ON INDEX - 4*(NUMBER OF CALLS TO TABRD)               GDF         4
        C  ***     DIMENSION ON TABLE - (4*(NO. OF IND. VAR.)+3)*(NO. OF CALLS TO  GDF         5
        C  *                                                                       GDF         6
              COMMON/GDF/NTABLE,INDEX(20),TABLE(200)                               GDF         7
              DATA XPMIN /-675.81/                                                 DESCRIB    21
              M          = 3*(ITAB - 1) + 1                                        DESCRIB    22
              RATIO      = 0.0                                                     DESCRIB    23
        C  *                                                                       DESCRIB    24
        C  ***     SET UP CALCULATION LOOP.                                        DESCRIB    25
        C  *                                                                       DESCRIB    26
              J          = INDEX(M) + INDEX(M+1) + INDEX(M+2) + 1                  DESCRIB    27
              K          = INDEX(M+2) - 1                                          DESCRIB    28
              YO         = TABLE(J) + RATIO*(TABLE(J+1) - TABLE(J))                DESCRIB    29
              I1         = INDEX(M) + 2*INDEX(M+1) + INDEX(M+2)                    DESCRIB    30
              I2         = I1 + K                                                  DESCRIB    31
              SO         = TABLE(I1+1) + RATIO*(TABLE(I1+2*K+1) - TABLE(I1+1))     DESCRIB    32
              XX1        = TABLE(I2) + RATIO*(TABLE(I2+2*K) - TABLE(I2))           DESCRIB    33
              SF         = 0.0                                                     DESCRIB    34
              BE         = 0.0                                                     DESCRIB    35
              RE         = 0.0                                                     DESCRIB    36
              BO         = 0.0                                                     DESCRIB    37
              IF(BIAS.NE.0.0) BO = 2.0*XX1 - SO                                    DESCRIB    38
              RO         = 2.0*XX1 - SO                                            DESCRIB    39
              J          = INDEX(M) + INDEX(M+1)                                   DESCRIB    40
        C  *                                                                       DESCRIB    41
        C  ***     DESCRIBING FUNCTION CALCULATION LOOP.                           DESCRIB    42
        C  *                                                                       DESCRIB    43
              DO 70 I=1,K                                                          DESCRIB    44
              XX1        = TABLE(J+I) + BIAS                                       DESCRIB    45
              XX2        = TABLE(J+I) - BIAS                                       DESCRIB    46
              PI1        = 1.0                                                     DESCRIB    47
              PI2        = 1.0                                                     DESCRIB    48
              IF(XX1 .LT. 0.0) PI1 = 0.0                                           DESCRIB    49
              IF(XX2 .LT. 0.0) PI2 = 0.0                                           DESCRIB    50
              IF(SIGMA .EQ. 0.0) GO TO 65                                          DESCRIB    51
              XX1        = XX1/SIGMA                                               DESCRIB    52
              XX2        = XX2/SIGMA                                               DESCRIB    53
```

```
          PI1         = C.5*(1.0 + ERF(0.70710678*XX1))                DESCRIB    54
          PI2         = 0.5*(1.0 + ERF(0.70710678*XX2))                DESCRIB    55
          XP1         = -0.5*XX1*XX1                                   DESCRIB    56
          XP2         = -0.5*XX2*XX2                                   DESCRIB    57
          IF(XP1 .LT. XPMIN) XP1 = XPMIN                               DESCRIB    58
          IF(XP2 .LT. XPMIN) XP2 = XPMIN                               DESCRIB    59
          G1          = XX1*PI1 + 0.39894228*EXP(XP1)                  DESCRIB    60
          G2          = XX2*PI2 + 0.39894228*EXP(XP2)                  DESCRIB    61
   65     CONTINUE                                                     DESCRIB    62
   C  ***      EVEN COMPONENT CALCULATIONS.                            DESCRIB    63
          XX1         = TABLE(I2+I) + RATIO*(TABLE(I2+2*K+I) - TABLE(I2+I))  DESCRIB    64
          XX2         = XX1 - SE                                       DESCRIB    65
          SE          = XX1                                            DESCRIB    66
          IF(BIAS.NE.0.0) BE = BE - 2.0*XX2*TABLE(J+I)/BIAS + XX2*SIGMA*(  DESCRIB    67
         1                  G1 + G2)/BIAS                              DESCRIB    68
          RE          = RE + XX2*(PI1 - PI2)                           DESCRIB    69
          IF(I.EQ.1) GO TO 70                                          DESCRIB    70
   C  ***      ODD COMPONENT CALCULATIONS.                             DESCRIB    71
          XX1         = TABLE(I1+I) + RATIO*(TABLE(I1+2*K+I) - TABLE(I1+I))  DESCRIB    72
          XX2         = SO - XX1                                       DESCRIB    73
          SO          = XX1                                            DESCRIB    74
          IF(BIAS.NE.0.0) BO = BO + XX2*SIGMA*(G1 - G2)/BIAS           DESCRIB    75
          RO          = RO + XX2*(PI1 + PI2)                           DESCRIB    76
   70     CONTINUE                                                     DESCRIB    77
   C                                                                   DESCRIB    78
   C  *****************     CALCULATE OUTPUT MEAN AND VARIANCE    ************ DESCRIB    79
   C                                                                   DESCRIB    80
          OMEAN       = BIAS*(BE + BO) + YO                            DESCRIB    81
          OVAR        = SIGMA*(RE + RO)                                DESCRIB    82
          OVAR        = OVAR*OVAR                                      DESCRIB    83
          REPRO       = RE + RO                                        DESCRIB    84
          RETURN                                                       DESCRIB    85
          END                                                          DESCRIB    86
```

```
      SUBROUTINE ELLIPSE(XP,YP,DXP,DYP,DXYP,ANGLE,STARTX,DELX,STARTY,       ELLIPSE      2
     *                   DELY,SCALXX,SCALYY)                               ELLIPSE      3
C************************************************************************ ELLIPSE      4
C*                                                                      * ELLIPSE      5
C*      ROUTINE TO PLACE AN ELLIPSE ON A CALCOMP PLOT.                  * ELLIPSE      6
C*                                                                      * ELLIPSE      7
C*    INPUT ARGUMENTS                                                   * ELLIPSE      8
C*      XP        X COORDINATE OF CENTER OF ELLIPSE.                    * ELLIPSE      9
C*      YP        Y COORDINATE OF CENTER OF ELLIPSE.                    * ELLIPSE     10
C*      DX        ONE-HALF LENGTH OF X ELLIPTICAL AXIS.                 * ELLIPSE     11
C*      DXP       ONE-HALF LENGTH OF X ELLIPTICAL AXIS (SIGMA X)        * ELLIPSE     12
C*      DYP       ONE-HALF LENGTH OF Y ELLIPTICAL AXIS (SIGMA Y)        * ELLIPSE     13
C*      DXYP      CROSS CORRELATION TERM (SIGMA XY)                     * ELLIPSE     14
C*      DY        ONE-HALF LENGTH OF Y ELLIPTICAL AXIS.                 * ELLIPSE     15
C*      ANGLE     PLOT ROTATION ANGLE.                                  * ELLIPSE     16
C*      STARTX    INITIAL X VALUE.                                      * ELLIPSE     17
C*      DELX      INCREMENT PER INCH ON X AXIS.                         * ELLIPSE     18
C*      STARTY    INITIAL Y VALUE.                                      * ELLIPSE     19
C*      DELY      INCREMENT PER INCH ON Y AXIS.                         * ELLIPSE     20
C*      SCALXX    SCALE FACTOR FOR X ELLIPTICAL AXIS                    * ELLIPSE     21
C*      SCALYY    SCALE FACTOR FOR Y ELLIPTICAL AXIS                    * ELLIPSE     22
C*                                                                      * ELLIPSE     23
C************************************************************************ ELLIPSE     24
C                                                                       C ELLIPSE     25
C***************        CALCULATE ANGLE OF ROTATION        ***************C ELLIPSE     26
C***************         DUE TO CROSS CORRELATION          ***************C ELLIPSE     27
C                                                                       C ELLIPSE     28
      IF(DXP .EQ. 0.0 .AND. DYP .EQ. 0.0) RETURN                           ELLIPSE     29
      DXP2     = DXP*DXP                                                   ELLIPSE     30
      DYP2     = DYP*DYP                                                   ELLIPSE     31
      DELTA    = DXP2*DYP2 - DXYP*DXYP                                     ELLIPSE     32
      IF(DELTA .NE. 0.0) GO TO 10                                          ELLIPSE     33
      ANG      = 1.5707963                                                 ELLIPSE     34
      GO TO 20                                                             ELLIPSE     35
   10 CONTINUE                                                             ELLIPSE     36
      A11      = DYP2/DELTA                                                ELLIPSE     37
      A12      = -DXYP/DELTA                                               ELLIPSE     38
      A22      = DXP2/DELTA                                                ELLIPSE     39
      ANG      = 0.5*ATAN(-2.0*A12/(A22 - A11))                            ELLIPSE     40
   20 CONTINUE                                                             ELLIPSE     41
      SIN2A    = SIN(2.0*ANG)                                              ELLIPSE     42
      SINA2    = SIN(ANG)**2                                               ELLIPSE     43
      COSA2    = COS(ANG)**2                                               ELLIPSE     44
      B11      = A11*COSA2 + A12*SIN2A + A22*SINA2                         ELLIPSE     45
      B22      = A11*SINA2 - A12*SIN2A + A22*COSA2                         ELLIPSE     46
      DX       = SQRT(1.3863/B11) * SCALXX                                 ELLIPSE     47
      DY       = SQRT(1.3863/B22) * SCALYY                                 ELLIPSE     48
      X        = (XP - STARTX)/DELX                                        ELLIPSE     49
      Y        = (YP - STARTY)/DELY                                        ELLIPSE     50
      CALL ROTATE(X,Y,ANGLE,-1,XR,YR)                                      ELLIPSE     51
      ANG      = ANG*57.29578                                              ELLIPSE     52
      X        = XR                                                        ELLIPSE     53
      Y        = YR                                                        ELLIPSE     54
      CALL ROTATE(X,Y,ANG,0,XR,YR)                                         ELLIPSE     55
      ANG      = ANG + ANGLE                                               ELLIPSE     56
C                                                                       C ELLIPSE     57
C***************        CALCULATE SPLINING PARAMETERS      ***************C ELLIPSE     58
```

```
      C                                                                 C ELLIPSE    59
            DXX      = ABS(DX)                                            ELLIPSE    60
            DYY      = ABS(DY)                                            ELLIPSE    61
            X        = XP - DXX                                           ELLIPSE    62
            Y        = YP                                                 ELLIPSE    63
            XX       = (X - STARTX)/DELX                                  ELLIPSE    64
            YY       = (Y - STARTY)/DELY                                  ELLIPSE    65
            CALL ROTATE(XX,YY,ANG,1,XR,YR)                                ELLIPSE    66
            CALL PLOT(XR,YR,3)                                            ELLIPSE    67
            XX       = ABS(DXX/DELX)                                      ELLIPSE    68
            YY       = ABS(DYY/DELY)                                      ELLIPSE    69
            XDUM1    = SQRT(XX*XX + YY*YY)                                ELLIPSE    70
            IF(XX.LT.0.025.OR.YY.LT.0.025.OR.XDUM1.LT.0.025) GO TO 60     ELLIPSE    71
            INUM     = IFIX(10.0*XDUM1 + 0.5)                             ELLIPSE    72
            IF(XDUM1.LT.1.0) INUM = IFIX(20.0*XDUM1 + 0.5)                ELLIPSE    73
            IF(INUM.LT.3) INUM = 3                                        ELLIPSE    74
            XDUM1    = DXX/FLOAT(INUM)                                    ELLIPSE    75
            XDUM2    = DYY*DYY/(DXX*DXX)                                  ELLIPSE    76
            SIGN     = 1.0                                                ELLIPSE    77
      C                                                                 C ELLIPSE    78
      C**************              PLOT THE ELLIPSE          **************C ELLIPSE    79
      C                                                                 C ELLIPSE    80
            DO 40 I=1,4                                                   ELLIPSE    81
            DO 30 K=1,INUM                                                ELLIPSE    82
            X        = X + SIGN*XDUM1                                     ELLIPSE    83
            XDUM3    = DYY*DYY - (X - XP)*(X - XP)*XDUM2                  ELLIPSE    84
            Y        = YP                                                 ELLIPSE    85
            IF(XDUM3.GT.0.0) Y = YP + SIGN*SQRT(XDUM3)                    ELLIPSE    86
            XX       = (X - STARTX)/DELX                                  ELLIPSE    87
            YY       = (Y - STARTY)/DELY                                  ELLIPSE    88
            CALL ROTATE(XX,YY,ANG,1,XR,YR)                                ELLIPSE    89
            CALL PLOT(XR,YR,2)                                            ELLIPSE    90
      30    CONTINUE                                                      ELLIPSE    91
            X        = XP                                                 ELLIPSE    92
            IF(I.NE.2) GO TO 40                                           ELLIPSE    93
            X        = XP + DXX                                           ELLIPSE    94
            SIGN     =-1.0                                                ELLIPSE    95
      40    CONTINUE                                                      ELLIPSE    96
            XX       = (XP - DXX - STARTX)/DELX                           ELLIPSE    97
            YY       = (YP - STARTY)/DELY                                 ELLIPSE    98
            CALL ROTATE(XX,YY,ANG,1,XR,YR)                                ELLIPSE    99
            CALL PLOT(XR,YR,2)                                            ELLIPSE   100
      C                                                                 C ELLIPSE   101
      C**************            PLOT ELLIPTICAL AXES        **************C ELLIPSE   102
      C                                                                 C ELLIPSE   103
      60    XX       = (XP + DXX - STARTX)/DELX                           ELLIPSE   104
            YY       = (YP - STARTY)/DELY                                 ELLIPSE   105
            CALL ROTATE(XX,YY,ANG,1,XR,YR)                                ELLIPSE   106
            CALL PLOT(XR,YR,2)                                            ELLIPSE   107
            XX       = (XP - STARTX)/DELX                                 ELLIPSE   108
            YY       = (YP + DYY - STARTY)/DELY                           ELLIPSE   109
            CALL ROTATE(XX,YY,ANG,1,XR,YR)                                ELLIPSE   110
            CALL PLOT(XR,YR,3)                                            ELLIPSE   111
            XX       = (XP - STARTX)/DELX                                 ELLIPSE   112
            YY       = (YP - DYY - STARTY)/DELY                           ELLIPSE   113
            CALL ROTATE(XX,YY,ANG,1,XR,YR)                                ELLIPSE   114
            CALL PLOT(XR,YR,2)                                            ELLIPSE   115
```

```
115           PFTURN                                                          ELLIPSE   116
              ENC                                                             ELLIPSE   117
```

```
      FUNCTION ERF(XX)                                                  ERF       2
C  ******************************************************************** ERF       3
C  ***                                                                  ERF       4
C  ***    ROUTINE TO EVALUATE ERROR FUNCTION ASSOC. WITH NORMAL CURVE.  ERF       5
C  ***                                                                  ERF       6
C  ***    XX - IN - INPUT ARGUMENT.                                     ERF       7
C  ***                                                                  ERF       8
C  ******************************************************************** ERF       9
      DIMENSION P(5),Q(3),P1(8),Q1(7),P2(5),Q2(4)                       ERF      10
C  *                                                                    ERF      11
C  ***    COEFFICIENTS FOR 0.0 .LE. ABS(XX) .LT. .477.                  ERF      12
C  *                                                                    ERF      13
      DATA  P/ -0.44422647396874E+00 ,  0.10731707253648E+02 ,          ERF      14
     A          0.15915606197771E+02 ,  0.37481624081284E+03 ,          ERF      15
     B          0.25612422994823E-01 /                                  ERF      16
      DATA  Q/  0.17903143558843E+02 ,  0.12482892031581E+03 ,          ERF      17
     A          0.33217224470532E+03 /                                  ERF      18
C  *                                                                    ERF      19
C  ***    COEFFICIENTS FOR .477 .LE. ABS(XX) .LE. 4.0.                  ERF      20
C  *                                                                    ERF      21
      DATA P1/  0.72117582508831E+01 ,  0.10731707253648E+02 ,          ERF      22
     A          0.15298928504694E+03 ,  0.33932081673434E+03 ,          ERF      23
     B          0.45191895371187E+03 ,  0.30045926102016E+03 ,          ERF      24
     C         -0.13686485738272E-06 ,  0.56419551747897E+00 /          ERF      25
      DATA Q1/  0.77000152935229E+02 ,  0.27758544474399E+03 ,          ERF      26
     A          0.63898026446563E+03 ,  0.93135409485061E+03 ,          ERF      27
     B          0.79095092532790E+03 ,  0.30045926095698E+03 ,          ERF      28
     C          0.12782727319629E+02 /                                  ERF      29
C  *                                                                    ERF      30
C  ***    COEFFICIENTS FOR 4.0 .LT. ABS(XX) .LE. 5.6875.                ERF      31
C  *                                                                    ERF      32
      DATA P2/ -0.22695659353969E+00 , -0.49473091062325E-01 ,          ERF      33
     A         -0.29961070770354E-02 , -0.22319245973418E-01 ,          ERF      34
     B         -0.27866130860965E+00 /                                  ERF      35
      DATA Q2/  0.10516751070679E+01 ,  0.19130892610783E+00 ,          ERF      36
     A          0.10620923052847E-01 ,  0.19873320181714E+01 /          ERF      37
C  *                                                                    ERF      38
C  ***    CONSTANTS.                                                    ERF      39
C  *                                                                    ERF      40
      DATA    XMIN , XLARGE ,               SSQPI /                     ERF      41
     A     1.0E-08 , 5.6875 , 0.56418958354776 /                        ERF      42
      DATA XPMIN /-675.81/                                              ERF      43
      SIGN = 1.0                                                        ERF      44
      IF(XX.LT.0.0) SIGN = -1.0                                         ERF      45
      X    = SIGN*XX                                                    ERF      46
      XSQ  = X*X                                                        ERF      47
      IF(X.GE.0.4770) GO TO 20                                          ERF      48
C  *                                                                    ERF      49
C  ***    EVALUATE ERF FOR 0.0 .LE. ABS(XX) .LT. 0.4770.                ERF      50
C  *                                                                    ERF      51
      ERF = SIGN*X*P(4)/Q(3)                                            ERF      52
      IF(X.LT.XMIN) GO TO 70                                            ERF      53
      ERF = P(5)                                                        ERF      54
      DO 10 I=1,4                                                       ERF      55
      ERF = ERF*XSQ + P(I)                                              ERF      56
   10 CONTINUE                                                          ERF      57
      ERF = SIGN*X*ERF/(((Q(1) + XSQ)*XSQ + Q(2))*XSQ + Q(3))           ERF      58
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```
         GO TO 70                                                        ERF      59
   20    IF(X.GT.4.0) GO TO 40                                           ERF      60
   C  *                                                                  ERF      61
   C  ***     EVALUATE ERF FOR 0.4770 .LE. ABS(XX) .LE. 4.0.             ERF      62
   C  *                                                                  ERF      63
         ERF = P1(7)*X + P1(8)                                           ERF      64
         DUM = X + Q1(7)                                                 ERF      65
         DO 30 I=1,6                                                     ERF      66
         ERF = ERF*X + P1(I)                                             ERF      67
         DUM = DUM*X + Q1(I)                                             ERF      68
   30    CONTINUE                                                        ERF      69
         XP = -XSQ                                                       ERF      70
         IF(XP .LT. XPMIN) XP = XPMIN                                    ERF      71
         ERF = SIGN*(1.0 - ERF*EXP(XP)/DUM)                              ERF      72
         GO TO 70                                                        ERF      73
   40    IF(X.GT.XLARGE) GO TO 60                                        ERF      74
   C  *                                                                  ERF      75
   C  ***     EVALUATE ERF FOR 4.0 .LT. ABS(XX) .LE. 5.6875.             ERF      76
   C  *                                                                  ERF      77
         XSQ = 1.0/XSQ                                                   ERF      78
         ERF = P2(4)*XSQ + P2(5)                                         ERF      79
         DUM = XSQ + Q2(4)                                               ERF      80
         DO 50 I=1,3                                                     ERF      81
         ERF = ERF*XSQ + P2(I)                                           ERF      82
         DUM = DUM*XSQ + Q2(I)                                           ERF      83
   50    CONTINUE                                                        ERF      84
         XP = -1.0/XSQ                                                   ERF      85
         IF(XP .LT. XPMIN) XP = XPMIN                                    ERF      86
         ERF = SIGN*(1.0 - EXP(XP)*((SSQPI + XSQ*ERF/DUM)/X))            ERF      87
         GO TO 70                                                        ERF      88
   C  *                                                                  ERF      89
   C  ***     EVALUATE ERF FOR ABS(XX) .GT. 5.6875.                      ERF      90
   C  *                                                                  ERF      91
   60    ERF = SIGN                                                      ERF      92
   70    RETURN                                                          ERF      93
         END                                                             ERF      94
```

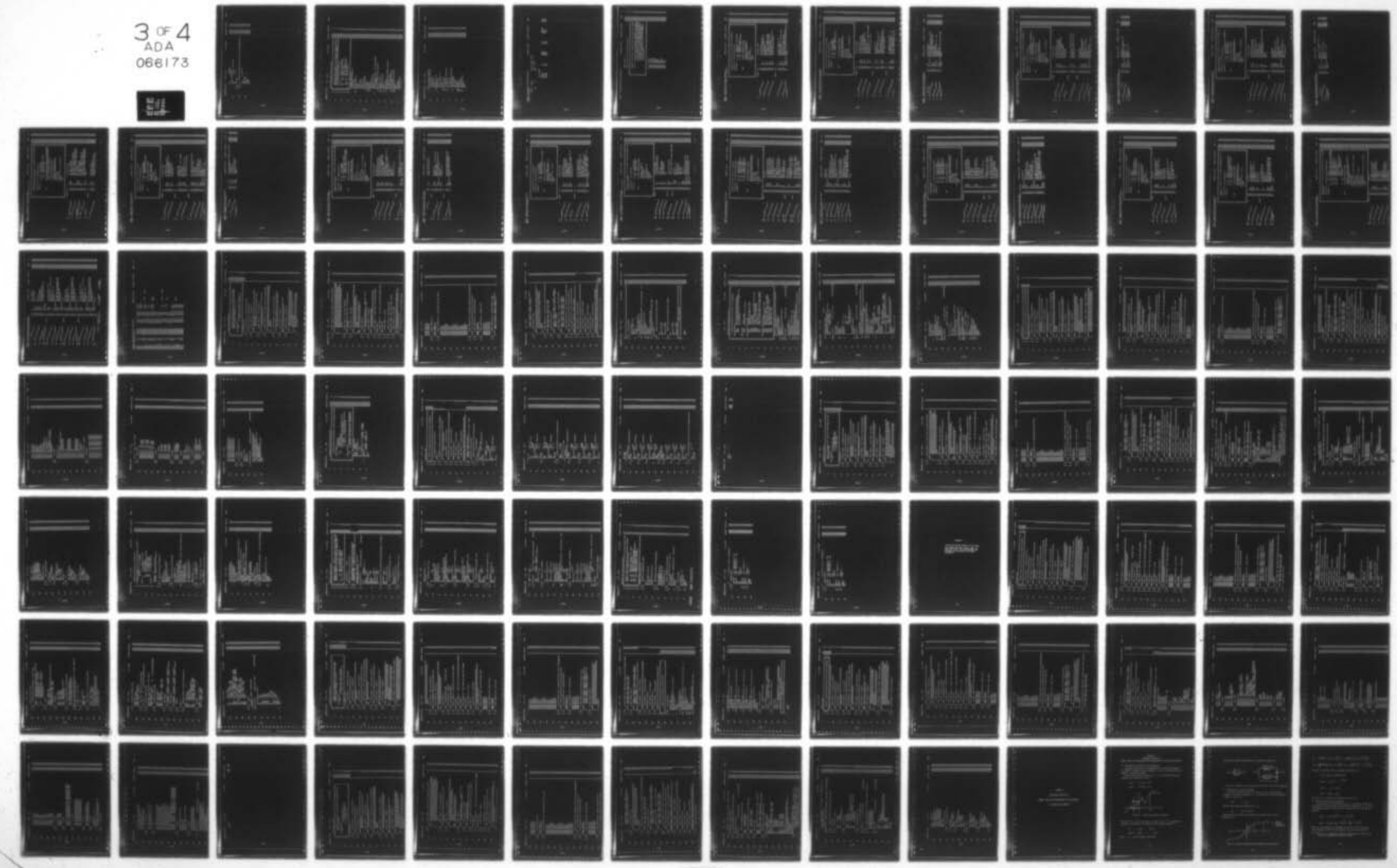
```
SUBROUTINE KUTTA       74/74    OPT=1                                    FTN 4.6+428          12/08/78  15.13.13          PAGE     1

                  SUBROUTINE KUTTA                                                            KUTTA       2
            C  ************************************************************************* KUTTA       3
            C  ***                                                                        KUTTA       4
            C  ***     ROUTINE TO PERFORM THIRD ORDER RUNGE-KUTTA INTEGRATION.            KUTTA       5
            C  ***                                                                        KUTTA       6
            C  ************************************************************************* KUTTA       7
            C  *                                                                          R2          2
            C  ***     REAL VARIABLES (PROBLEM DEPENDENT).                                R2          3
            C  *                                                                          R2          4
                  COMMON R(6)                                                             R2          5
            C  *                                                                          R2          6
            C  ***     INTEGRATION VARIABLES (LOCATIONS ARE PROBLEM DEPENDENT).           R2          7
            C  *                                                                          R2          8
                  EQUIVALENCE (TI,R(1)),(TO,R(2)),(DT,R(3)),(DTOUT,R(4)),                 R2          9
                 A            (DTOUT2,R(5)),(TMAX,R(6))                                   R2         10
            C  *                                                                          I           2
            C  ***     I ARRAY SEGMENT 1 - INTEGER VARIABLES.                             I           3
            C  *                                                                          I           4
                  COMMON/INTEGER/ICEES,NEQU,NSTATES,NPA,NOM,NGM,NPE,NPX,NOAW,NOINIT       I           5
            C  *                                                                          I           6
            C  ***     I ARRAY SEGMENT 4 - DERIVATIVE INDICES.                            I           7
            C  *                                                                          I           8
                  COMMON/INTEGER/ INDX1(14)                                               I           9
            C  *                                                                          I          10
            C  ***     I ARRAY SEGMENT 5 - STATE INDICES.                                 I          11
            C  *                                                                          I          12
                  COMMON/INTEGER/ INDX2(14)                                               I          13
            C  *                                                                          I          14
            C  ***     I ARRAY SEGMENT 6 - VARIOUS INDICES.                               I          15
            C  *                                                                          I          16
                  COMMON/INTEGER/ INDXPD,INDXP,INDXPED,INDXPE,INDXPXD,INDXPX              I          17
            C  *****************************************************************    C I          18
            C  *                                                                          INTEG       2
            C  ***     TEMPORARY INTEGRATION STORAGE.                                     INTEG       3
            C  ***     DIMENSION = NEQU = NSTATES + NPA**2 + NPX**2 + NPE**2              INTEG       4
            C  *                                                                          INTEG       5
                  COMMON/INTEG/ RI(2187),RT(2187)                                         INTEG       6
            C  *                                                                          KUTTA      11
            C  ***     COMPLETE FIRST STAGE AT THIS INTEGRATION STEP.                     KUTTA      12
            C  *                                                                          KUTTA      13
            C  ***     STATES.                                                            KUTTA      14
                  DO 10 I=1,NSTATES                                                       KUTTA      15
                  RI(I)         = R(INDX2(I))                                             KUTTA      16
                  RT(I)         = DT*R(INDX1(I))                                          KUTTA      17
                  R(INDX2(I)) = RI(I) + 0.5*RT(I)                                         KUTTA      18
            10    CONTINUE                                                                KUTTA      19
            C  ***     P.                                                                 KUTTA      20
                  NL1 = NSTATES + 1                                                       KUTTA      21
                  NU1 = NSTATES + NPA * NPA                                               KUTTA      22
                  I1            = INDXPD                                                  KUTTA      23
                  I2            = INDXP                                                   KUTTA      24
                  DO 20 I=NL1,NU1                                                         KUTTA      25
                  RI(I)         = R(I2)                                                   KUTTA      26
                  RT(I)         = DT*R(I1)                                                KUTTA      27
                  R(I2)         = RI(I) + 0.5*RT(I)                                       KUTTA      28
                  I1            = I1 + 1                                                  KUTTA      29
                  I2            = I2 + 1                                                  KUTTA      30
```

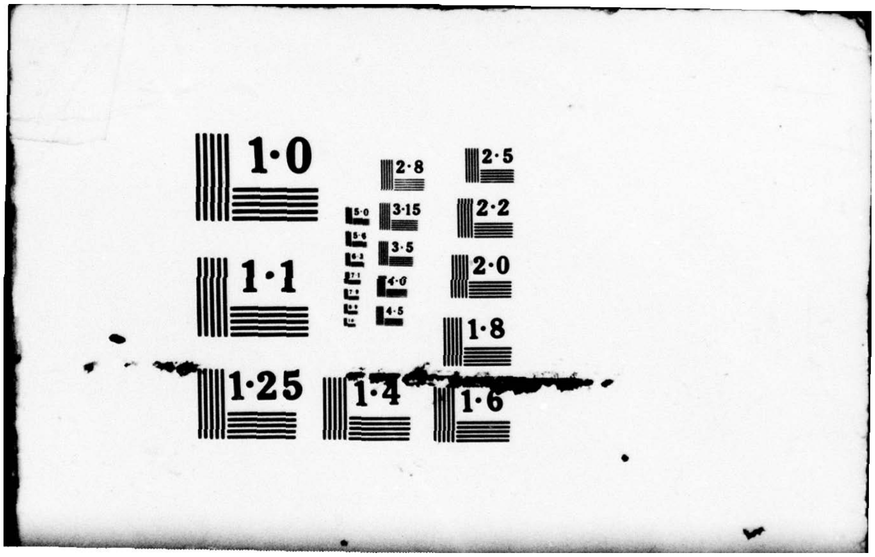
```
 20    CONTINUE                                                       KUTTA     31
 C  ***    PF.                                                        KUTTA     32
       NL2             = NU1 + 1                                      KUTTA     33
       NU2             = NU1 + NPE * NPE                              KUTTA     34
       I1              = INDXPED                                      KUTTA     35
       I2              = INDXPE                                       KUTTA     36
       DO 21 I=NL2,NU2                                                KUTTA     37
       RI(I)           = R(I2)                                        KUTTA     38
       RT(I)           = DT*P(I1)                                     KUTTA     39
       R(I2)           = RI(I) + 0.5*RT(I)                            KUTTA     40
       I1              = I1 + 1                                       KUTTA     41
       I2              = I2 + 1                                       KUTTA     42
 21    CONTINUE                                                       KUTTA     43
 C  ***    PX.                                                        KUTTA     44
       NL3             = NU2 + 1                                      KUTTA     45
       NEQU            = NU2 + NPX * NPX                              KUTTA     46
       I1              = INDXPXD                                      KUTTA     47
       I2              = INDXPX                                       KUTTA     48
       DO 22 I=NL3,NEQU                                               KUTTA     49
       RI(I)           = R(I2)                                        KUTTA     50
       RT(I)           = DT*R(I1)                                     KUTTA     51
       R(I2)           = RI(I) + 0.5*RT(I)                            KUTTA     52
       I1              = I1 + 1                                       KUTTA     53
       I2              = I2 + 1                                       KUTTA     54
 22    CONTINUE                                                       KUTTA     55
 C  *                                                                 KUTTA     56
 C  ***      SECOND STAGE.                                            KUTTA     57
 C  *                                                                 KUTTA     58
       TI              = TO + 0.5*DT                                  KUTTA     59
       CALL DEQU                                                      KUTTA     60
       CALL PROP                                                      KUTTA     61
       TEMP1           = 2.0*DT                                       KUTTA     62
       TEMP2           = TEMP1/3.0                                    KUTTA     63
       TEMP3           = 0.166666666667                               KUTTA     64
 C  ***     STATES.                                                   KUTTA     65
       DO 30 I=1,NSTATES                                              KUTTA     66
       R(INDX2(I)) = RI(I) + TEMP1*R(INDX1(I)) - RT(I)                KUTTA     67
 30    CONTINUE                                                       KUTTA     68
       DO 40 I=1,NSTATES                                              KUTTA     69
       RT(I)           = RI(I) + TEMP2*R(INDX1(I)) + TEMP3*RT(I)      KUTTA     70
 40    CONTINUE                                                       KUTTA     71
 C  ***     P.                                                        KUTTA     72
       I1              = INDXPD                                       KUTTA     73
       I2              = INDXP                                        KUTTA     74
       DO 50 I=NL1,NU1                                                KUTTA     75
       R(I2)           = RI(I) + TEMP1*R(I1) - RT(I)                  KUTTA     76
       I1              = I1 + 1                                       KUTTA     77
       I2              = I2 + 1                                       KUTTA     78
 50    CONTINUE                                                       KUTTA     79
       I1              = INDXPD                                       KUTTA     80
       I2              = INDXP                                        KUTTA     81
       DO 60 I=NL1,NU1                                                KUTTA     82
       RT(I)           = RI(I) + TEMP2*R(I1) + TEMP3*RT(I)            KUTTA     83
       I1              = I1 + 1                                       KUTTA     84
       I2              = I2 + 1                                       KUTTA     85
 60    CONTINUE                                                       KUTTA     86
 C  ***    PF.                                                        KUTTA     87
```

```
            I1             = INDXPED                                      KUTTA      88
            I2             = INDXPE                                       KUTTA      89
            DO 61 I=NL2,NU2                                               KUTTA      90
            R(I2)          = RI(I) + TEMP1*R(I1) - RT(I)                  KUTTA      91
            I1             = I1 + 1                                       KUTTA      92
            I2             = I2 + 1                                       KUTTA      93
   61       CONTINUE                                                      KUTTA      94
            I1             = INDXPED                                      KUTTA      95
            I2             = INDXPE                                       KUTTA      96
            DO 62 I=NL2,NU2                                               KUTTA      97
            RT(I)          = RI(I) + TEMP2*R(I1) + TEMP3*RT(I)            KUTTA      98
            I1             = I1 + 1                                       KUTTA      99
            I2             = I2 + 1                                       KUTTA     100
   62       CONTINUE                                                      KUTTA     101
   C  ***      PX.                                                        KUTTA     102
            I1             = INDXPXD                                      KUTTA     103
            I2             = INDXPX                                       KUTTA     104
            DO 63 I=NL3,NEQU                                              KUTTA     105
            R(I2)          = RI(I) + TEMP1*R(I1) - RT(I)                  KUTTA     106
            I1             = I1 + 1                                       KUTTA     107
            I2             = I2 + 1                                       KUTTA     108
   63       CONTINUE                                                      KUTTA     109
            I1             = INDXPXD                                      KUTTA     110
            I2             = INDXPX                                       KUTTA     111
            DO 64 I=NL3,NEQU                                              KUTTA     112
            RT(I)          = RI(I) + TEMP2*R(I1) + TEMP3*RT(I)            KUTTA     113
            I1             = I1 + 1                                       KUTTA     114
            I2             = I2 + 1                                       KUTTA     115
   64       CONTINUE                                                      KUTTA     116
   C  *                                                                   KUTTA     117
   C  ***      THIRD STAGE.                                               KUTTA     118
   C  *                                                                   KUTTA     119
            TI             = TO + DT                                      KUTTA     120
            CALL DECU                                                     KUTTA     121
            CALL PROP                                                     KUTTA     122
            TEMP1          = DT/6.0                                       KUTTA     123
   C  ***      STATES.                                                    KUTTA     124
            DO 70 I=1,NSTATES                                             KUTTA     125
            R(INDX2(I)) = RT(I) + TEMP1*R(INDX1(I))                       KUTTA     126
   70       CONTINUE                                                      KUTTA     127
   C  ***      P.                                                         KUTTA     128
            I1             = INDXPD                                       KUTTA     129
            I2             = INDXP                                        KUTTA     130
            DO 80 I=NL1,NU1                                               KUTTA     131
            R(I2)          = RT(I) + TEMP1*R(I1)                          KUTTA     132
            I1             = I1 + 1                                       KUTTA     133
            I2             = I2 + 1                                       KUTTA     134
   80       CONTINUE                                                      KUTTA     135
   C  ***      PE.                                                        KUTTA     136
            I1             = INDXPED                                      KUTTA     137
            I2             = INDXPE                                       KUTTA     138
            DO 90 I=NL2,NU2                                               KUTTA     139
            R(I2)          = RT(I) + TEMP1*R(I1)                          KUTTA     140
            I1             = I1 + 1                                       KUTTA     141
            I2             = I2 + 1                                       KUTTA     142
   90       CONTINUE                                                      KUTTA     143
   C  ***      PY.                                                        KUTTA     144
```

AD-A066 173 VOUGHT CORP DALLAS TEX F/G 1/2
VOLAR: A DIGITAL COMPUTER PROGRAM FOR SIMULATING VSTOL AIRCRAFT--ETC(U)
DEC 78 J WOLKOVITCH, R B BRASSELL N62269-77-R-0389
UNCLASSIFIED 2-32000/8R-51672-VOL-2 NADC-77123-30-VOL-2 NL

3 OF 4
ADA
066173

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2·8
2·5
3·15
2·2
5·0
5·6
3·5
1·1
2·0
4·0
4·5
1·8
1·25
1·4
1·6

```
                 I1          = INDXPXD                                           KUTTA     145
                 I2          = INDXPX                                            KUTTA     146
                 DO 100 I=NL3,NEQU                                               KUTTA     147
                 R(I2)       = RI(I) + TEMP1*R(I1)                               KUTTA     148
                 I1          = I1 + 1                                            KUTTA     149
                 I2          = I2 + 1                                            KUTTA     150
             100 CONTINUE                                                        KUTTA     151
           C   *                                                                 KUTTA     152
           C   ***    GENERATE DERIVATIVES AND STATES FOR NEXT INTEGRATION STEP. KUTTA     153
           C   *                                                                 KUTTA     154
                 TO          = TO + DT                                           KUTTA     155
                 ICEES       = 0                                                 KUTTA     156
                 CALL DEQU                                                       KUTTA     157
                 CALL PROP                                                       KUTTA     158
                 ICEES       = 2                                                 KUTTA     159
                 RETURN                                                          KUTTA     160
                 END                                                             KUTTA     161
```

```
            SUBROUTINE MATINV (TEMP,N,DIT,NDIM)                                  MATINV      2
      C  ********************************************************************** MATINV      3
      C  ***                                                                    MATINV      4
      C  ***    ROUTINE TC INVERT A MATRIX.  THE INVERSE IS FOUND BY ITERATION MATINV      5
      C  ***    ON AN INVERSE DETERMINED BY USING A MODIFIED GAUSSIAN          PATINV      6
      C  ***    ELIMINATION AND CONDITIONING.  TWO WORKING MATRICIES DIMENSION MATINV      7
      C  ***    N BY 2*N AND 2*N ARE NECESSARY.                                MATINV      8
      C  ***                                                                    PATINV      9
      C  ***    TEMP - IN  - MATRIX TO BF INVERTED.                             PATINV     10
      C  ***    N    - IN  - NUMBER CF ROWS IN TEMP.                            PATINV     11
      C  ***    DET  - OUT - SINGULAR FLAG.                                     PATINV     12
      C  ***                 DET = 0, SINGULAR MATRIX.                          MATINV     13
      C  ***    NDIM - IN  - ROW DIMENSION OF TEMP.                             PATINV     14
      C  ***    TEMP - CUT - INVERTED MATRIX.                                   MATINV     15
      C  ***                                                                    PATINV     16
      C  ********************************************************************** PATINV     17
            DIMENSION TEMP(NDIM,1)                                               MATINV     18
            DIMENSION A(17,34),ICOL(34)                                          MATINV     19
            DC 255 I=1,N                                                         MATINV     20
            DC 255 J=1,N                                                         MATINV     21
        255 A(I,J)= TEMP(I,J)                                                    MATINV     22
            N20=2*N                                                              MATINV     23
            N2=N+1                                                               MATINV     24
            DO 200 I=1,N                                                         MATINV     25
            DO 200 J=1,N                                                         MATINV     26
            NK=N+J                                                               MATINV     27
            A(I,NK)=A(I,J)                                                       MATINV     28
            IF (I-J) 60,50,60                                                    MATINV     29
         50 A(I,J)=1.                                                            MATINV     30
            GO TO 200                                                            MATINV     31
         60 A(I,J)=0.                                                            MATINV     32
        200 CONTINUE                                                             MATINV     33
            DO 600 K=1,N                                                         MATINV     34
            AMAX= ABS (A(K,N2))                                                  MATINV     35
            IMAX=N2                                                              MATINV     36
      C     LOCATE MAXIMUM ELEMENT.  FILE COLUMN NUMBER                          MATINV     37
            DO 560 J=N2,N20                                                      MATINV     38
            IF ( ABS (A(K,J))-AMAX) 560,560,555                                  PATINV     39
        555 IMAX=J                                                               PATINV     40
            AMAX= ABS (A(K,J))                                                   MATINV     41
        560 CONTINUE                                                             MATINV     42
            IF(AMAX) 562,561,562                                                 MATINV     43
       561  DET=0.                                                               MATINV     44
            GO TO 950                                                            MATINV     45
        562 ICOL(K)=IMAX                                                         MATINV     46
      C     ZERO OFF REMAINING ELEMENTS IN COLUMN                                MATINV     47
            DO 600 I=1,N                                                         MATINV     48
            IF (I-K) 570,600,570                                                 PATINV     49
        570 ATEMP=A(I,IMAX)/A(K,IMAX)                                            MATINV     50
            DO 599 J=1,N20                                                       MATINV     51
        599 A(I,J)=A(I,J)-A(K,J)*ATEMP                                           MATINV     52
        600 CONTINUE                                                             MATINV     53
            DET=1.                                                               MATINV     54
            DO 65C I=1,N                                                         MATINV     55
            IMAX=ICOL(I)                                                         MATINV     56
            DET=DET*A(I,IMAX)                                                    MATINV     57
            DO 65C J=1,N                                                         MATINV     58
```

```
  650 A(I,J)=A(I,J)/A(I,IMAX)                                          MATINV    59
C     SHIFT RIGHT AND REARRANGE                                        MATINV    60
      DO 700 I=1,N                                                     MATINV    61
      IMAX=ICOL(I)-N                                                   MATINV    62
      DO 700 J=1,N                                                     MATINV    63
      NK=J+N                                                           MATINV    64
  700 A(IMAX,NK)=A(I,J)                                                MATINV    65
C     SHIFT LEFT                                                       MATINV    66
      DO 750 I=1,N                                                     MATINV    67
      ICOL(I) = ICOL(I) - N                                            MATINV    68
      DO 750 J=1,N                                                     MATINV    69
      NK=J+N                                                           MATINV    70
  750 A(I,J)=A(I,NK)                                                   MATINV    71
  800 DO 900 I=1,N                                                     MATINV    72
      IF (ICOL(I)-I) 848,900,848                                       MATINV    73
  848 NTEMP=ICOL(I)                                                    MATINV    74
      KJ= I+1                                                          MATINV    75
      DO 850 J=KJ,N                                                    MATINV    76
      IF (ICOL(J)-I) 850,849,850                                       MATINV    77
  849 ICOL(I)=ICOL(J)                                                  MATINV    78
      ICOL(J)= NTEMP                                                   MATINV    79
      DET= -DET                                                        MATINV    80
      GO TO 900                                                        MATINV    81
  850 CONTINUE                                                         MATINV    82
  900 CONTINUE                                                         MATINV    83
  950 DO 256 I=1,N                                                     MATINV    84
      DO 256 J=1,N                                                     MATINV    85
  256 TEMP(I,J)= A(I,J)                                                MATINV    86
      RETURN                                                           MATINV    87
      END                                                              MATINV    88
```

```
MATRIX - MISCELLANEOUS MATRIX OPERATIONS.                    COMPASS 3.3-428.     12/08/78  15.15.17.     PAGE      1
STORAGE ALLOCATION.

         ADDRESS   LENGTH               BINARY CONTROL CARDS.

               0       235               IDENT  MATRIX
             235                         END

                          ENTRY POINTS.

                          MULTNR             0+         TRANNN            62+          MULTABT         152+
                          MULTNN             7+         ADDNM             75+          MULTC           171+
                          MULTNT            23+         ADDNN            110+          SUB             200+
                          MULTTN            36+         ADDTR            117+          LAYIN           210+
                          MULTNNA           52+         MULT             131+
                                IDENT  MATRIX                                                  MATRIX        2
                                                                                               MATRIX        4
                                COMMENT MISCELLANEOUS MATRIX OPERATIONS.                       MATRIX        5
                                                                                               MATRIX        6
                          ********************************************************************** MATRIX      7
                          **                                                                   MATRIX        8
                          **    ROUTINE TO PERFORM ALL REQUIRED MATRIX OPERATIONS IN THE STACK MATRIX        9
                          **                                                                   MATRIX       10
                          **    NOTES : 1) AN OUTPUT MATRIX CANNOT BE EQUIVALENT TO AN INPUT   MATRIX       11
                          **               MATRIX IN ANY ROUTINE WHICH INVOLVES MULTIPLICATION MATRIX       12
                          **               OF TWO MATRICIES. IT IS ALLOWED IN ALL OTHER ROUTIN MATRIX       13
                          **            2) THESE ROUTINES ASSUME THAT SQUARE MATRICIES ARE     MATRIX       14
                          **               DIMENSIONED N BY N. OVER DIMENSIONING IS ALLOWED IF MATRIX       15
                          **               THE MATRIX IS TREATED AS A SINGLE-DIMENSIONED       MATRIX       16
                          **               ARRAY. THE EQUIVALENT OF A(I,J) MAY BE ADDRESSED    MATRIX       17
                          **               AS A(J*(N-1)+I).                                    MATRIX       18
                          **                                                                   MATRIX       19
                          ********************************************************************** MATRIX     20
                                                                                               MATRIX       21
                                ENTRY  MULTNR                                                  MATRIX       22
                                ENTRY  MULTNN                                                  MATRIX       23
                                ENTRY  MULTNT                                                  MATRIX       24
                                ENTRY  MULTTN                                                  MATRIX       25
                                ENTRY  MULTNNA                                                 MATRIX       26
                                ENTRY  TRANNN                                                  MATRIX       27
                                ENTRY  ADDNM                                                   MATRIX       28
                                ENTRY  ADDNN                                                   MATRIX       29
                                ENTRY  ADDTP                                                   MATRIX       30
                                ENTRY  MULT                                                    MATRIX       31
                                ENTRY  MULTABT                                                 MATRIX       32
                                ENTRY  MULTC                                                   MATRIX       33
                                ENTRY  SUB                                                     MATRIX       34
                                ENTRY  LAYIN                                                   MATRIX       35
```

```
                                 ************************************************************************** MATRIX
                                 **                                                                      ** MATRIX
                                 **          ROUTINE TO MULTIPLY AN N BY N MATRIX BY A CONSTANT.         ** MATRIX
                                 **                                                                      ** MATRIX
                                 **          CALLING SEQ : CALL MULTNR(A,R,B,N)                          ** MATRIX
                                 **                                                                      ** MATRIX
                                 **          ARGUMENTS   : A - IN  - MATRIX TO BE MULTIPLIED.            ** MATRIX
                                 **                        R - IN  - CONSTANT.                           ** MATRIX
                                 **                        B - OUT - RESULTANT MATRIX.                   ** MATRIX
                                 **                        N - IN  - NUMBER OF ROWS IN MATRIX.           ** MATRIX
                                 **                                                                      ** MATRIX
                                 **          NOTE        : FORTRAN EQUIVALENT ROUTINE                    ** MATRIX
                                 **                                                                      ** MATRIX
                                 **                        SUBROUTINE MULTNR(A,R,B,N)                    ** MATRIX
                                 **                        DIMENSION A(N,N),B(N,N)                       ** MATRIX
                                 **                        DO 10 J=1,N                                   ** MATRIX
                                 **                        DO 10 I=1,N                                   ** MATRIX
                                 **                     10 P(I,J) = R*A(I,J)                             ** MATRIX
                                 **                        RETURN                                        ** MATRIX
                                 **                        END                                           ** MATRIX
                                 **                                                                      ** MATRIX
                                 ************************************************************************** MATRIX
                                                                                                            MATRIX
 0                  1   MULTNR   BSS    1            ENTRY/EXIT POINT                                       MATRIX
                                                                                                            MATRIX
 1 6110000001                    SB1    1            SET REG B1 TO 1                                        MATRIX
             63210               SB2    X1           SET REG B2 TO FWA OF *A*                               MATRIX
                   54111         SA1    A1+B1        SET REG X1 TO ADDRESS OF *R*                           MATRIX
 2 53210                         SA2    X1           GET CONTENTS OF *R*                                    MATRIX
       24202                     NX2    X2           NORMALIZE *R*                                          MATRIX
             54111               SA1    A1+B1        SET REG X1 TO ADDRESS OF *B*                           MATRIX
                   63310         SB3    X1           MOVE ADDRESS OF *B* TO REG B3                          MATRIX
 3 54111                         SA1    A1+B1        SET REG X1 TO ADDRESS OF *N*                           MATRIX
       53310                     SA3    X1           GET CONTENTS OF *N*                                    MATRIX
             42333               IX3    X3*X3        COMPUTE NUMBER OF ELEMENTS IN *B*                      MATRIX
                   63433         SB4    B3+X3        SET REG B4 TO LWA+1 OF *B*                             MATRIX
                                                                                                            MATRIX
 4                      LOOP.1   BSS    0                                                                   MATRIX
                                                                                                            MATRIX
 4 56320                         SA3    B2           GET NEXT ELEMENT OF *A*                                MATRIX
       24303                     NX3    X3           NORMALIZE ELEMENT                                      MATRIX
             66221               SB2    B2+B1        COMPUTE NEXT ELEMENT ADDRESS IN *A*                    MATRIX
                   40623         FX6    X2*X3        MULTIPLY BY *R*                                        MATRIX
 5 56630                         SA6    B3           STORE IN NEXT ELEMENT OF *B*                           MATRIX
       66331                     SB3    B3+B1        COMPUTE NEXT ELEMENT ADDRESS IN *B*                    MATRIX
             0734000004 +        LT     B3,B4,LOOP.1 CONTINUE LOOP UNTIL ALL ELEMENTS MULTIPLIE MATRIX
 6 0400000000 +                  EQ     MULTNR       RETURN                                                 MATRIX
```

```
                                    ********************************************************************************* MATRIX
                                    **                                                                            ** MATRIX
                                    **        ROUTINE TO MULTIPLY TWO N BY N MATRICIES.                           ** MATRIX
                                    **                                                                            ** MATRIX
                                    **        CALLING SEQ : CALL MULTNN(A,B,C,N)                                  ** MATRIX
                                    **                                                                            ** MATRIX
                                    **        ARGUMENTS   : A - IN  - N BY N MATRIX.                              ** MATRIX
                                    **                      B - IN  - N BY N MATRIX.                              ** MATRIX
                                    **                      C - OUT - RESULTANT MATRIX.                           ** MATRIX
                                    **                      N - IN  - NUMPER OF ROWS IN MATRIX.                   ** MATRIX
                                    **                                                                            ** MATRIX
                                    **                                                                            ** MATRIX
                                    **        NOTE        : FORTRAN EQUIVALENT ROUTINE                            ** MATRIX
                                    **                                                                            ** MATRIX
                                    **                      SUBROUTINE MULTNN(A,B,C,N)                            ** MATRIX
                                    **                      DIMENSION A(N,N),B(N,N),C(N,N)                        ** MATRIX
                                    **                      DO 10 I=1,N                                           ** MATRIX
                                    **                      DO 10 J=1,N                                           ** MATRIX
                                    **                      C(I,J) = 0.0                                          ** MATRIX
                                    **                      DO 10 K=1,N                                           ** MATRIX
                                    **                   10 C(I,J)= C(I,J) + A(I,K)*B(K,J)                        ** MATRIX
                                    **                      RETURN                                                ** MATRIX
                                    **                      END                                                   ** MATRIX
                                    **                                                                            ** MATRIX
                                    ********************************************************************************* MATRIX
                                                                                                                     MATRIX
      7                   1   MULTNN  BSS   1         ENTRY/EXIT POINT                                               MATRIX
                                                                                                                     MATRIX
     10  6110000001                   SB1   1         SET REG B1 TO 1                                                MATRIX
                 54211                SA2   A1+B1     SET PEG X2 TO FWA OF *B*                                       MATRIX
                      54321           SA3   A2+B1     SET PEG X3 TO FWA OF *C*                                       MATRIX
     11  63230                        SB2   X3        MCVE FWA CF *C* TO REG B2                                      MATRIX
            54331                     SA3   A3+B1     SET REG X3 TO ADDRESS OF *N*                                   MATRIX
                 53330                SA3   X3        GET CONTENTS OF *N*                                            MATRIX
                      43000           MX0   0         CLEAR REG X0                                                   MATRIX
     12  42433                        IX4   X3*X3     CALCULATE NUMBER OF ELEMENTS IN MATRIX                         MATRIX
            43700                     MX7   0         CLEAR REG X7                                                   MATRIX
                 63342                SB3   B2+X4     SET REG B3 TO LWA+1 OF *C*                                     MATRIX
                                                                                                                     MATRIX
     13                       LOOP.2  BSS   0                                                                        MATRIX
                                                                                                                     MATRIX
     13  42437                        IX4   X3*X7     CALCULATE N*(J-1)                                              MATRIX
            43600                     MX6   0         CLEAR REG X6                                                   MATRIX
                 36442                IX4   X4+X2     CALCULATE ADDRESS OF *B(1,J)*                                  MATRIX
                      46000           NO              NC-OP                                                          MATRIX
     14  63440                        SB4   X4        STORE ADDRESS IN REG B4                                        MATRIX
            36401                     IX4   X0+X1     CALCULATE ADDRESS OF *A(I,1)*                                  MATRIX
                 63534                SB5   B4+X3     SET REG B5 TO ADDRESS OF *B(N,J)*                              MATRIX
                      63640           SB6   X4        STORE ADDRESS IN REG B6                                        MATRIX
                                                                                                                     MATRIX
     15                       LOOP.3  BSS   0                                                                        MATRIX
                                                                                                                     MATRIX
     15  56440                        SA4   B4        GET CONTENTS OF *B(K,J)*                                       MATRIX
            56560                     SA5   B6        GET CONTENTS OF *A(I,K)*                                       MATRIX
                 66441                SB4   B4+B1     GFT NEXT FLEMENT ADDRESS OF *B*                                MATRIX
                      40445           FX4   X4*X5     CCMPUTE A(I,K)*B(K,J)                                          MATRIX
     16  63636                        SB6   B6+X3     GET NEXT ELEMENT ADDRESS OF *A*                                MATRIX
```

```
            30664                     FX6     X6+X4         SUM INTO *C(I,J)*                            MATRIX     142
                24606                 NX6     X6            NORMALIZE RESULT                             MATRIX     143
     17  0745000015 +                 LT      B4,B5,LOOP.3  CONTINUE LOOP UNTIL *B(N,J)* FOUND           MATRIX     144
                56620                 SA6     B2            STORE SUMMATION INTO *C(I,J)*                MATRIX     145
                     66221            SB2     B2+B1         GET NEXT ELEMENT ADDRESS OF *C*              MATRIX     146
     20  73001                        SX0     X0+B1         INCREMENT *I*                                MATRIX     147
            37503                     IX5     X0-X3         COMPARE WITH *N*                             MATRIX     148
                0315000013 +          NZ      X5,LOOP.2     CONTINUE LOOP UNTIL *I* = *N*                MATRIX     149
     21  43000                        MX0     0             CLEAR *I*                                    MATRIX     150
            73771                     SX7     X7+B1         INCREMENT *J*                                MATRIX     151
                0723000013 +          LT      B2,B3,LOOP.2  CONTINUE LOOP UNTIL *C(N,N)* FOUND           MATRIX     152
     22  0400000007 +                 EQ      MULTNN        RETURN                                       MATRIX     153
```

```
                                ********************************************************************** MATRIX     155
                                **                                                                  ** MATRIX     156
                                **      ROUTINE TO MULTIPLY AN N BY N MATRIX BY THE TRANSPOSE OF    ** MATRIX     157
                                **      ANOTHER N BY N MATRIX.                                      ** MATRIX     158
                                **                                                                  ** MATRIX     159
                                **      CALLING SEQ : CALL MULTNT(A,B,C,N)                          ** MATRIX     160
                                **                                                                  ** MATRIX     161
                                **      ARGUMENTS   : A - IN  - N BY N MATRIX.                      ** MATRIX     162
                                **                    B - IN  - N BY N MATRIX TO BE TRANSPOSED.     ** MATRIX     163
                                **                    C - OUT - RESULTANT MATRIX.                   ** MATRIX     164
                                **                    N - IN  - NUMBER OF ROWS IN MATRIX.           ** MATRIX     165
                                **                                                                  ** MATRIX     166
                                **      NOTE        : FORTRAN EQUIVALENT ROUTINE                    ** MATRIX     167
                                **                                                                  ** MATRIX     168
                                **                    SUBROUTINE MULTNT(A,B,C,N)                    ** MATRIX     169
                                **                    DIMENSION A(N,N),B(N,N),C(N,N)                ** MATRIX     170
                                **                    DO 10 I=1,N                                   ** MATRIX     171
                                **                    DO 10 J=1,N                                   ** MATRIX     172
                                **                    C(I,J) = C.0                                  ** MATRIX     173
                                **                    DO 10 K=1,N                                   ** MATRIX     174
                                **                 10 C(I,J) = C(I,J + A(I,K)*B(J,K)                ** MATRIX     175
                                **                    RETURN                                        ** MATRIX     176
                                **                    END                                           ** MATRIX     177
                                **                                                                  ** MATRIX     178
                                ********************************************************************** MATRIX     179
                                                                                                       MATRIX     180
   23                  1      MULTNT   BSS    1              ENTRY/EXIT POINT                          MATRIX     181
                                                                                                       MATRIX     182
   24  6110000001                      SB1    1              SET REG B1 TO 1                           MATRIX     183
                 54211                 SA2    A1+B1          SET REG X2 TO FWA OF *B*                  MATRIX     184
                      54321            SA3    A2+B1          SET REG X3 TO FWA OF *C*                  MATRIX     185
   25  63230                           SB2    X3             MOVE FWA OF *C* TO REG B2                 MATRIX     186
            54331                      SA3    A3+B1          SET REG X3 TO ADDRESS OF *N*              MATRIX     187
                 53330                 SA3    X3             SET REG X3 TO *N*                         MATRIX     188
                      63330            SB3    X3             MOVE *N* TO REG B3                        MATRIX     189
   26  66400                           SB4    B0             CLEAR REG B4                              MATRIX     190
            66500                      SB5    B0             CLEAR REG B5                              MATRIX     191
                                                                                                       MATRIX     192
   27                         LOOP.4   BSS    0                                                        MATRIX     193
                                                                                                       MATRIX     194
   27  73014                           SX0    X1+B4          SET REG X0 TO ADDRESS OF *A(I,1)*         MATRIX     195
            43600                      MX6    C              CLEAR REG X6                              MATRIX     196
                 73725                 SX7    X2+B5          SET REG X7 TO ADDRESS OF *B(J,1)*         MATRIX     197
                      66600            SB6    B0             CLEAR REG B6                              MATRIX     198
                                                                                                       MATRIX     199
   30                         LOOP.5   BSS    0                                                        MATRIX     200
                                                                                                       MATRIX     201
   30  53400                           SA4    X0             LOAD *A(I,K)*                             MATRIX     202
            53570                      SA5    X7             LOAD *B(J,K)*                             MATRIX     203
                 36003                 IX0    X0+X3          CALCULATE NEXT *A* ADDRESS                MATRIX     204
                      40445            FX4    X4*X5          COMPUTE A(I,K)*B(J,K)                     MATRIX     205
   31  66661                           SB6    B6+B1          INCREMENT K                               MATRIX     206
            36773                      IX7    X7+X3          CALCULATE NEXT *B* ADDRESS                MATRIX     207
                 30664                 FX6    X6+X4          SUM RESULT                                MATRIX     208
                      24606            NX6    X6             NORMALIZE RESULT                          MATRIX     209
   32  0763000030 +                    LT     B6,B3,LOOP.5   LOOP UNTIL K = *N*                        MATRIX     210
                 56620                 SA6    B2             STORE SUMMATION INTO *C(I,J)*             MATRIX     211
                 66441          SB4   B4+B1           INCREMENT I                                    MATRIX    212
   33  66221                    SB2   B2+B1           CALCULATE NEXT ADDRESS OF *C*                  MATRIX    213
          074300C027 +          LT    B4,B3,LOOP.4    LOOP UNTIL I = *N*                             MATRIX    214
                 664C0          SB4   B0              CLEAR I                                        MATRIX    215
   34  66551                    SB5   B5+B1           INCFEMENT J                                    MATRIX    216
          075300C027 +          LT    B5,B3,LOOP.4    LOOP UNTIL J = *N*                             MATRIX    217
   35  0400000023 +             EQ    MULTNT          RETURN                                         MATRIX    218
```

```
                                   ******************************************************************************* MATRIX
                                   **                                                                          ** MATRIX
                                   **        ROUTINE TO MULTIPLY THE TRANSPOSE OF AN N BY N MATRIX BY          ** MATRIX
                                   **        ANOTHER N BY N MATRIX.                                            ** MATRIX
                                   **                                                                          ** MATRIX
                                   **        CALLING SEQ : CALL MULTTN(A,B,C,N)                                ** MATRIX
                                   **                                                                          ** MATRIX
                                   **        ARGUMENTS   : A - IN  - N BY N MATRIX TO BE TRANSPOSED.           ** MATRIX
                                   **                      B - IN  - N BY N MATRIX.                            ** MATRIX
                                   **                      C - OUT - RESULTANT MATRIX.                         ** MATRIX
                                   **                      N - IN  - NUMBER OF ROWS.                           ** MATRIX
                                   **                                                                          ** MATRIX
                                   **        NOTE        : FORTRAN EQUIVALENT ROUTINE                          ** MATRIX
                                   **                                                                          ** MATRIX
                                   **                      SUBROUTINE MULTTN(A,B,C,N)                          ** MATRIX
                                   **                      DIMENSION A(N,N),B(N,N),C(N,N)                      ** MATRIX
                                   **                      DO 10 I=1,N                                         ** MATRIX
                                   **                      DO 10 J=1,N                                         ** MATRIX
                                   **                      C(I,J) = 0.0                                        ** MATRIX
                                   **                      DO 10 K=1,N                                         ** MATRIX
                                   **                   10 C(I,J) = C(I,J) + A(K,I)*B(K,J)                     ** MATRIX
                                   **                      RETURN                                              ** MATRIX
                                   **                      END                                                 ** MATRIX
                                   **                                                                          ** MATRIX
                                   ******************************************************************************* MATRIX
                                                                                                                  MATRIX
 36                      1   MULTTN   BSS    1            ENTRY/EXIT POINT                                        MATRIX
                                                                                                                  MATRIX
 37  6110000001                       SB1    1            SET REG B1 TO 1                                         MATRIX
               54211                  SA2    A1+B1        SET REG X2 TO FWA OF *B*                                MATRIX
                    54321             SA3    A2+B1        SET REG X3 TO FWA OF *C*                                MATRIX
 40  43600                            MX6    0            CLEAR REG X6                                            MATRIX
          63230                       SB2    X3           MOVE FWA OF *C* TO REG B2                               MATRIX
               54331                  SA3    A3+B1        GET ADDRESS OF *N*                                      MATRIX
                    43700             MX7    0            CLEAR REG X7                                            MATRIX
 41  53330                            SA3    X3           GET CONTENTS OF *N*                                     MATRIX
          63330                       SB3    X3           MOVE *N* TO REG B3                                      MATRIX
               42433                  IX4    X3*X3        CALCULATE NUMBER OF ELEMENTS IN MATRIX                  MATRIX
                    63440             SB4    X4           MOVE RESULT TO REG B4                                   MATRIX
 42  66500                            SB5    B0           CLEAR I                                                 MATRIX
          66600                       SB6    B0           CLEAR J                                                 MATRIX
               66700                  SB7    B0           CLEAR K                                                 MATRIX
                                                                                                                  MATRIX
 43                          LOOP.6   BSS    0                                                                    MATRIX
                                                                                                                  MATRIX
 43  53415                            SA4    X1+B5        LOAD *A(K,I)*                                           MATRIX
          53526                       SA5    X2+B6        LOAD *B(K,J)*                                           MATRIX
               66771                  SB7    B7+B1        INCREMENT K                                             MATRIX
                    40445             FX4    X4*X5        CALCULATE A(K,I)*B(K,J)                                 MATRIX
 44  66551                            SB5    B5+B1        INCREMENT I                                             MATRIX
          30664                       FX6    X6+X4        SUM RESULT INTO ACCUMULATOR                             MATRIX
               24606                  NX6    X6           NORMALIZE RESULT                                        MATRIX
                    66661             SB6    B6+B1        INCREMENT J                                             MATRIX
 45  0773000043 +                     LT     B7,B3,LOOP.6 LOOP UNTIL K = *N*                                      MATRIX
               56620                  SA6    B2           STORE RESULT INTO *C(I,J)*                              MATRIX
                    63670             SB6    X7           RESET J                                                 MATRIX
 46  43600                            MX6    0            CLEAR ACCUMULATOR                                       MATRIX
```

```
MATRIX - MISCELLANEOUS MATRIX OPERATIONS.                         COMPASS 3.3-428.     12/08/78  15.15.17.     PAGE      9
MULTTN - MULTIPLY TRANSPOSE BY N BY N MATRIX.

          66221                       SB2    B2+B1           CALCULATE NEXT ADDRESS OF *C*                    MATRIX    277
               66700                  SB7    B0              CLEAR K                                          MATRIX    278
   47  0754000043 +                   LT     B5,B4,LOOP.6 LOOP UNTIL I = N*N                                  MATRIX    279
               66500                  SB5    B0              CLEAR I                                          MATRIX    280
                    73773             SX7    X7+B3           INCREMENT J RESET VALUE                          MATRIX    281
   50  63670                          SB6    X7              RESET J                                          MATRIX    282
          0764000043 +                LT     B6,B4,LOOP.6 LOOP UNTIL J = N*N                                  MATRIX    283
   51  0400000036 +                   EQ     MULTTN                                                           MATRIX    284
```

```
                                   ************************************************************************ MATRIX     286
                                   **                                                                   ** MATRIX     287
                                   **         ROUTINE TO MULTIPLY TWO N BY N MATRICIES AND SUM THE RESULT ** MATRIX     288
                                   **         INTO A THIRD N BY N MATRIX.                               ** MATRIX     289
                                   **                                                                   ** MATRIX     290
                                   **         CALLING SEQ : CALL MULTNNA(A,B,C,N)                       ** MATRIX     291
                                   **                                                                   ** MATRIX     292
                                   **         ARGUMENTS   : A - IN  - N BY N MATRIX.                    ** MATRIX     293
                                   **                       B - IN  - N BY N MATRIX.                    ** MATRIX     294
                                   **                       C - I/O - RESULTANT N BY N MATRIX.          ** MATRIX     295
                                   **                       N - IN  - NUMBER OF ROWS.                   ** MATRIX     296
                                   **                                                                   ** MATRIX     297
                                   **         NOTE        : THIS IS DONE BY REPLACING THE WORD FOLLOWING ** MATRIX     298
                                   **                       *LOOP.2* IN ROUTINE *MULTNN* BY THE WORD AT ** MATRIX     299
                                   **                       *CODE.1* THEN CALLING *MULTNN*.             ** MATRIX     300
                                   **                                                                   ** MATRIX     301
                                   **                     : FORTRAN EQUIVALENT ROUTINE                  ** MATRIX     302
                                   **                                                                   ** MATRIX     303
                                   **                       SUBROUTINE MULTNNA(A,B,C,N)                 ** MATRIX     304
                                   **                       DIMENSION A(N,N),B(N,N),C(N,N)              ** MATRIX     305
                                   **                       DO 10 I=1,N                                 ** MATRIX     306
                                   **                       DO 10 J=1,N                                 ** MATRIX     307
                                   **                       DO 10 K=1,N                                 ** MATRIX     308
                                   **                    10 C(I,J) = C(I,J) + A(I,K)*B(K,J)             ** MATRIX     309
                                   **                       RETURN                                      ** MATRIX     310
                                   **                       END                                         ** MATRIX     311
                                   **                                                                   ** MATRIX     312
                                   ************************************************************************ MATRIX     313
                                                                                                           MATRIX     314
     52                   1        MULTNNA  BSS    1             ENTRY/EXIT POINT                          MATRIX     315
                                                                                                           MATRIX     316
     53  5120000013 +                       SA2    LOOP.2        GET WORD AT *LOOP.2*                      MATRIX     317
                   5130000061 +             SA3    CODE.1        GET WORD AT *CODE.1*                      MATRIX     318
     54  10622                              BX6    X2            MOVE WORD AT *LOOP.2* TO REG X6           MATRIX     319
              10733                         BX7    X3            MOVE WORD AT *CODE.1* TO REG X7           MATRIX     320
                   54630                    SA6    A3            STORE WORD AT *LOOP.2* INTO *CODE.1*      MATRIX     321
                        54720               SA7    A2            STORE WORD AT *CODE.1* INTO *LOOP.2*      MATRIX     322
     55  0100000007 +                       RJ     MULTNN        CALL *MULTNN*                             MATRIX     323
     56  5120000013 +                       SA2    LOOP.2        GET WORD AT *LOOP.2*                      MATRIX     324
                   5130000061 +             SA3    CODE.1        GET WORD AT *CODE.1*                      MATRIX     325
     57  10622                              BX6    X2            MOVE WORD AT *LOOP.2* TO REG X6           MATRIX     326
              10733                         BX7    X3            MOVE WORD AT *CODE.1* TO REG X7           MATRIX     327
                   54630                    SA6    A3            STORE WORD AT *LOOP.2* INTO *CODE.1*      MATRIX     328
                        54720               SA7    A2            STORE WORD AT *CODE.1* INTO *LOOP.2*      MATRIX     329
     60  0400000052 +                       EQ     MULTNNA       RETURN                                    MATRIX     330
                                                                                                           MATRIX     331
     61                            CODE.1   BSS    0                                                       MATRIX     332
                                                                                                           MATRIX     333
     61  42437                              IX4    X3*X7         CALCULATE N*(J-1)                         MATRIX     334
              56520                         SA5    B2            GET VALUE OF *C(I,J)*                     MATRIX     335
                   36442                    IX4    X4+X2         CALCULATE ADDRESS OF *B(1,J)*             MATRIX     336
                        10655               BX6    X5            MOVE VALUE OF *C(I,J)* TO REG X6          MATRIX     337
```

```
MATRIX - MISCELLANEOUS MATRIX OPERATIONS.                COMPASS 3.3-428.     12/08/78  15.15.17.      PAGE     11
TRANNN - TRANSPOSE N BY N MATRIX.

                               ************************************************************************************ MATRIX
                               **                                                                               ** MATRIX
                               **        ROUTINE TO TRANSPOSE AN N BY N MATRIX.                                 ** MATRIX
                               **                                                                               ** MATRIX
                               **        CALLING SEQ : CALL TRANNN(A,B,N)                                       ** MATRIX
                               **                                                                               ** MATRIX
                               **        ARGUMENTS   : A - IN  - N BY N MATRIX.                                 ** MATRIX
                               **                      B - OUT - RESULTANT MATRIX.                              ** MATRIX
                               **                      N - IN  - NUMBER OF ROWS IN MATRIX.                      ** MATRIX
                               **                                                                               ** MATRIX
                               **        NOTE        : FORTRAN EQUIVALENT ROUTINE                               ** MATRIX
                               **                                                                               ** MATRIX
                               **                      SUBROUTINE TRANNN(A,B,N)                                 ** MATRIX
                               **                      DIMENSION A(N,N),B(N,N)                                  ** MATRIX
                               **                      DO 10 I=1,N                                              ** MATRIX
                               **                      DO 10 J=1,N                                              ** MATRIX
                               **                   10 B(J,I) = A(I,J)                                          ** MATRIX
                               **                      RETURN                                                   ** MATRIX
                               **                      END                                                      ** MATRIX
                               **                                                                               ** MATRIX
                               ************************************************************************************ MATRIX
                                                                                                                   MATRIX
     62                 1      TRANNN    BSS     1               ENTRY/EXIT POINT                                  MATRIX
                                                                                                                   MATRIX
     63  6110000001                      SB1     1               SET REG B1 TO 1                                   MATRIX
                54211                    SA2     A1+B1           SET REG X2 TO FWA OF *B*                          MATRIX
                      54321              SA3     A2+B1           SET REG B3 TO ADDRESS OF *N*                      MATRIX
     64  53330                           SA3     X3              GET CONTENTS OF *N*                               MATRIX
          63230                          SB2     X3              SET REG B2 TO *N*                                 MATRIX
                67321                    SB3     B2-B1           SET REG B3 TO *N* - 1                             MATRIX
                      66400              SB4     B0              CLEAR REG B4                                      MATRIX
                                                                                                                   MATRIX
     65                        LOOP.7    BSS     0                                                                 MATRIX
                                                                                                                   MATRIX
     65  76440                           SX4     B4              SET REG X4 TO I                                   MATRIX
          42434                          IX4     X3*X4           CALCULATE I*N                                     MATRIX
                63644                    SB6     X4+B4           GET OFFSET FOR *(I,I)* ELEMENT                    MATRIX
                      53516              SA5     X1+B6           GET *A(I,I)*                                      MATRIX
     66  10655                           BX6     X5              MOVE TO REG X6                                    MATRIX
          53626                          SA6     X2+B6           STORE *A(I,I)* IN *B(I,I)*                        MATRIX
                66541                    SB5     B4+B1           SET J TO I+1                                      MATRIX
                      66760              SB7     B6              SET REG B7 TO *(I,I)* OFFSET                      MATRIX
                                                                                                                   MATRIX
     67                        LOOP.8    BSS     0                                                                 MATRIX
                                                                                                                   MATRIX
     67  66661                           SB6     B6+B1           GET OFFSET FOR *(J,I)* ELEMENT                    MATRIX
          66772                          SB7     B7+B2           GET OFFSET FOR *(I,J)*                            MATRIX
                53416                    SA4     X1+B6           GET *A(J,I)*                                      MATRIX
                      53517              SA5     X1+B7           GET *A(I,J)*                                      MATRIX
     70  10644                           BX6     X4              MOVE REG X4 TO X6                                 MATRIX
          53627                          SA6     X2+B7           SET *B(I,J)* TO *A(J,I)*                          MATRIX
                10755                    BX7     X5              MOVE REG X5 TO REG X7                             MATRIX
                      53726              SA7     X2+B6           SET *B(J,I)* TO *A(I,J)*                          MATRIX
     71  66551                           SB5     B5+B1           INCREMENT J                                       MATRIX
          0752000067 +                   LT      B5,B2,LOOP.8    LOOP UNTIL J = *N*                                MATRIX
                      66441              SB4     B4+B1           INCREMENT I                                       MATRIX
     72  0743000065 +                    LT      B4,B3,LOOP.7    LOOP UNTIL I = *N* - 1                            MATRIX
```

```
                 42433              IX4   X3*X3     CALCULATE NUMBER OF ELEMENTS IN MATRIX      MATRIX   396
                      63240         SP2   X4        STORE IN REG B2                             MATRIX   397
   73  67221                        SB2   B2-B1     SUBTRACT 1                                  MATRIX   398
            53512                   SA5   X1+B2     GET *A(N,N)*                                MATRIX   399
                 10655              BX6   X5        MOVE REG X5 TO REG X6                       MATRIX   400
                      53622         SA6   X2+B2     STORE INTO *B(N,N)*                         MATRIX   401
   74  0400000062 +                 EQ    TRANNN    RETURN                                      MATRIX   402
```

```
                          ********************************************************************** MATRIX
                          **                                                                  ** MATRIX
                          **        ROUTINE TC ADD AN M BY M MATRIX TO THE LOWER RIGHT HAND CORNER MATRIX
                          **        OF AN N BY N MATRIX.                                      ** MATRIX
                          **                                                                  ** MATRIX
                          **        CALLING SEQ : CALL ADDNM(A,B,C,N,M)                       ** MATRIX
                          **                                                                  ** MATRIX
                          **        ARGUMENTS   : A - IN  - N BY N MATRIX.                    ** MATRIX
                          **                      B - IN  - M BY M MATRIX.                    ** MATRIX
                          **                      C - OUT - RESULTANT N BY N MATRIX.          ** MATRIX
                          **                      N - IN  - NUMBER OF ROWS IN N BY N MATRIX.  ** MATRIX
                          **                      M - IN  - NUMBER OF ROWS IN M BY M MATRIX.  ** MATRIX
                          **                                                                  ** MATRIX
                          **        NOTE        : FORTRAN EQUIVALENT ROUTINE                  ** MATRIX
                          **                                                                  ** MATRIX
                          **                      SUBROUTINE ADDNM(A,B,C,N,M)                 ** MATRIX
                          **                      DIMENSION A(N,N),B(M,M),C(N,N)              ** MATRIX
                          **                      K = N - M                                   ** MATRIX
                          **                      L1 = 0                                      ** MATRIX
                          **                      DO 10 I=1,N                                 ** MATRIX
                          **                      IF(I .GT. K) L1 = L1 + 1                    ** MATRIX
                          **                      L2 = C                                      ** MATRIX
                          **                      DO 10 J=1,N                                 ** MATRIX
                          **                      C(I,J) = A(I,J)                             ** MATRIX
                          **                      IF(I .LE. K .OR. J .LE. K) GO TO 10         ** MATRIX
                          **                      L2 = L2 + 1                                 ** MATRIX
                          **                      C(I,J) = C(I,J) + B(L1,L2)                  ** MATRIX
                          **                   10 CONTINUE                                    ** MATRIX
                          **                      RETURN                                      ** MATRIX
                          **                      END                                         ** MATRIX
                          **                                                                  ** MATRIX
                          ********************************************************************** MATRIX
                                                                                                 MATRIX
   75                1   ADDNM    BSS   1               ENTRY/EXIT POINT                         MATRIX
                                                                                                 MATRIX
   76  6110000001                 SB1   1               SET REG B1 TC 1                          MATRIX
             54211                SA2   A1+B1           SET REG X2 TO FWA OF *B*                 MATRIX
                  54321           SA3   A2+B1           SET REG X3 TC FWA OF *C*                 MATRIX
   77  63230                      SB2   X3              STCRE FWA OF *C* IN REG B2               MATRIX
        54431                     SA4   A3+B1           SET REG X4 TO ADDRESS OF *N*             MATRIX
             54541                SA5   A4+B1           SET REG X5 TO ADDRESS OF *M*             MATRIX
                  53440           SA4   X4              GET CONTENTS OF *N*                      MATRIX
  100  63740                      SB7   X4              STORE IN REG B7                          MATRIX
        42644                     IX6   X4*X4           CALCULATE NUMBER OF ELEMENTS IN *C*      MATRIX
             63362                SB3   X6+B2           SET REG B3 TO LWA+1 OF *C*               MATRIX
                  53550           SA5   X5              GET VALUE OF *M*                         MATRIX
  101  66400                      SB4   B0              CLEAR *I*                                MATRIX
        37545                     IX5   X4-X5           CALCULATE *K*                            MATRIX
             66500                SB5   B0              CLEAR *J*                                MATRIX
                  63650           SB6   X5              STORE *K* IN REG B6                      MATRIX
                                                                                                 MATRIX
  102                    LOOP.9   BSS   0                                                        MATRIX
                                                                                                 MATRIX
  102  43400                      MX4   0               CLEAR REG X4                             MATRIX
        53510                     SA5   X1              GET CONTENTS CF NEXT ELEMENT OF *A*      MATRIX
             0756000104 +         LT    B5,B6,JMP.1     JUMP IF *J* LT *K*                       MATRIX
  103  0746000104 +               LT    B4,B6,JMP.1     JUMP IF *I* LT *K*                       MATRIX
```

```
ADDNM  - ADD M BY M MATRIX TO N BY N MATRIX.
                53420                    SA4    X2            GET NEXT ELEMENT OF *B*                     MATRIX
                      73221              SX2    X2+B1         INCREMENT INDEX INTO *B*                    MATRIX
                                                                                                          MATRIX
      104                      JMP.1     BSS    0                                                         MATRIX
                                                                                                          MATRIX
      104  66441                         SB4    B4+B1         INCREMENT *I*                               MATRIX
              30645                      FX6    X4+X5         COMPUTE *A(I,J) + B(I-N+M,J-N+M)*           MATRIX
                   24606                 NX6    X6            NORMALIZE RESULT                            MATRIX
                      73111              SX1    X1+B1         GET NEXT ELEMENT ADDRESS IN *A*             MATRIX
      105  0747000106 +                  LT     B4,B7,JMP.2   JUMP IF *I* LT *N*                          MATRIX
                66400                    SB4    B0            CLEAR *I*                                   MATRIX
                      66551              SB5    B5+B1         INCREMENT *J*                               MATRIX
                                                                                                          MATRIX
      106                      JMP.2     BSS    0                                                         MATRIX
                                                                                                          MATRIX
      106  56620                         SA6    A2            STORE SUM INTO NEXT ELEMENT OF *C*          MATRIX
              66221                      SB2    B2+B1         GET NEXT ELEMENT ADDRESS IN *C*             MATRIX
                 0723000102 +            LT     B2,B3,LOOP.9  LOOP UNTIL *C(N,N)* FOUND                   MATRIX
      107  0400000075 +                  EQ     ADDNM         RETURN                                      MATRIX
```

```
                                  ********************************************************************** MATRIX  481
                                  **                                                                  ** MATRIX  482
                                  **          RCUTINE TC ADD TWC N BY N MATRICIES.                    ** MATRIX  483
                                  **                                                                  ** MATRIX  484
                                  **          CALLING SEO : CALL ADDNN(A,P,C,N)                       ** PATRIX  485
                                  **                                                                  ** MATRIX  486
                                  **          ARGUMENTS   : A - IN  - N BY N MATRIX.                  ** MATRIX  487
                                  **                        B - IN  - N BY N MATRIX.                  ** PATRIX  488
                                  **                        C - OUT - RESULTANT MATRIX.               ** PATRIX  489
                                  **                        N - IN  - NUMBER OF ROWS IN N BY N MATRIX.** MATRIX  490
                                  **                                                                  ** MATRIX  491
                                  **          NOTE        : FCRTRAN EQUIVALENT POUTINE                ** MATRIX  492
                                  **                                                                  ** MATRIX  493
                                  **                        SUBRCUTINE ADDNN(A,B,C,N)                 ** MATRIX  494
                                  **                        DIMENSICN A(N,N),B(N,N),C(N,N)            ** MATRIX  495
                                  **                        DO 10 J=1,N                               ** MATRIX  496
                                  **                        DO 10 I=1,N                               ** MATRIX  497
                                  **                     10 C(I,J) = A(I,J) + B(I,J)                  ** MATRIX  498
                                  **                        RETURN                                    ** PATRIX  499
                                  **                        END                                       ** MATRIX  500
                                  **                                                                  ** MATRIX  501
                                  ********************************************************************** MATRIX  502
                                                                                                         MATRIX  503
    110                 1         ADDNN    BSS   1                ENTRY/EXIT POINT                       MATRIX  504
                                                                                                         MATRIX  505
    111  6110000001                        SB1   1                SET REG B1 TO 1                        MATRIX  506
                   54211                   SA2   A1+B1            SET REG X2 TC FWA OF *B*               MATRIX  507
                        54321              SA3   A2+B1            SET PEG X3 TC FWA OF *C*               MATRIX  508
    112  63230                             SB2   X3               MCVE FWA OF *C* TO REG B2              MATRIX  509
              54331                        SA3   A3+B1            GET ADDRESS OF *N*                     MATRIX  510
                   53330                   SA3   X3               GFT CONTENTS OF *N*                    MATRIX  511
                        42333              IX3   X3*X3            CALCULATE NUMBER OF ELEMENTS IN *C*    MATRIX  512
    113  63332                             SB3   B2+X3            SET REG B3 TO LWA+1 OF *C*             MATRIX  513
              76510                        SX5   B1               SET PEG X5 TO 1                        MATRIX  514
                                                                                                         MATRIX  515
    114                           LOOP.10  BSS   0                                                       MATRIX  516
                                                                                                         MATRIX  517
    114  53310                             SA3   X1               GET NEXT ELEMENT OF *A*                PATRIX  518
              53420                        SA4   X2               GET NEXT ELEMENT OF *B*                MATRIX  519
                   36115                   IX1   X1+X5            GET NEXT ELEMENT ADDRESS IN *A*        MATRIX  520
                        30634              FX6   X3+X4            CCMPUTE *A(I,J) + B(I,J)*              MATRIX  521
    115  24606                             NX6   X6               NCRMALIZE RESULT                       MATRIX  522
              36225                        IX2   X2+X5            GET NEXT ELEMENT ADDRESS IN *B*        MATRIX  523
                   56620                   SA6   B7               STORE IN NEXT ELEMENT OF *C*           MATRIX  524
                        66221              SB2   B2+B1            COMPUTE NEXT ELEMENT ADDRESS OF *C*    MATRIX  525
    116  0723000114 +                      LT    B2,B3,LOOP.10    LOCP UNTIL *C(N,N)* FOUND              PATRIX  526
                   0400000110 +            EQ    ADDNN            RETURN                                 MATRIX  527
                                                                                                         MATRIX  528
                                  ******************************************************************************* MATRIX
                                  **                                                                           ** MATRIX
                                  **          ROUTINE TO TRANSPOSE AN N BY N MATRIX AND ADD THE RESULT TO      ** MATRIX
                                  **          THE INITIAL MATRIX.                                              ** MATRIX
                                  **                                                                           ** MATRIX
                                  **          CALLING SEQ :  CALL ADDTR(A,N)                                   ** MATRIX
                                  **                                                                           ** MATRIX
                                  **          ARGUMENTS   :  A - IN  - N BY N MATRIX                           ** MATRIX
                                  **                         A - OUT - RESULTANT MATRIX                        ** MATRIX
                                  **                         N - IN  - NUMBER OF ROWS                          ** MATRIX
                                  **                                                                           ** MATRIX
                                  **          NOTE        :  FORTRAN EQUIVALENT ROUTINE                        ** MATRIX
                                  **                                                                           ** MATRIX
                                  **                         SUBROUTINE ADDTR(A,N)                             ** MATRIX
                                  **                         DIMENSION A(N,N)                                  ** MATRIX
                                  **                         DO 11 J=1,N                                       ** MATRIX
                                  **                         DO 11 I=J,N                                       ** MATRIX
                                  **                         A(I,J)=A(I,J)+A(J,I)                              ** MATRIX
                                  **                         A(J,I)=A(I,J)                                     ** MATRIX
                                  **                      11 CONTINUE                                          ** MATRIX
                                  **                         RETURN                                            ** MATRIX
                                  **                         END                                               ** MATRIX
                                  **                                                                           ** MATRIX
                                  ******************************************************************************* MATRIX
   117                  1         ADDTR    BSS     1               ENTRY/EXIT POINT                              MATRIX
   120  5021000001                         SA2     A1+1            SET X2 TO ADDRESS OF *N*                      MATRIX
                  53220                    SA2     X2              GET CONTENTS OF *N* IN X2                     MATRIX
                        63120              SB1     X2              *N*                                           MATRIX
   121  6120000001                         SB2     B0+1            *1* IN B2                                     MATRIX
                  66300                    SB3     B0              OUTER LOOP COUNTER                            MATRIX
                        66400              SB4     B0              INNER LOOP COUNTER                            MATRIX
   122  6252777776                         SB5     X2-1            SET B5 TO *N-1*                               MATRIX
                  66600                    SB6     B0              *I*                                           MATRIX
                        66700              SB7     B0              *J*                                           MATRIX
   123                            LOOP.12  BSS     0                                                             MATRIX
   123  66663                              SB6     B6+B3           I=I+OUTER LOOP COUNT                          MATRIX
              66760                        SB7     B6              J = I                                         MATRIX
                  66430                    SB4     B3              INNER LOOP STARTS AT VALUE OF OUTER LOOP      MATRIX
   124                            LOOP.11  BSS     0                                                             MATRIX
   124  53316                              SA3     X1+B6           GET A(I)                                      MATRIX
              53417                        SA4     X1+B7           GET A(J)                                      MATRIX
                  30634                    FX6     X3+X4           ADD A(I) TO A(J)                              MATRIX
                        24606              NX6                     NORMALIZE X6                                  MATRIX
   125  10766                              BX7     X6              COPY X6 INTO X7                               MATRIX
              54630                        SA6     A3              STORE A(I)                                    MATRIX
                  54740                    SA7     A4              STORE A(J)                                    MATRIX
                        66662              SB6     B6+B2           I = I + 1                                     MATRIX
   126  66771                              SB7     B7+B1           J = J + N                                     MATRIX
              66442                        SB4     B4+B2           INCREMENT INNER LOOP COUNT                    MATRIX
                  0741000124 +             LT      B4,B1,LOOP.11   END OF INNER LOOP                             MATRIX
   127  66332                              SB3     B3+B2           INCREMENT OUTER LOOP COUNT                    MATRIX
              0731000123 +                 LT      B3,B1,LOOP.12   END OF OUTER LOOP                             MATRIX
   130  0400000117 +                       EQ      ADDTR                                                         MATRIX
```

```
                              ************************************************************************ MATRIX
                              **                                                                    ** MATRIX
                              **      ROUTINE TO MULTIPLY TWO N BY M MATRICIES.                     ** MATRIX
                              **                                                                    ** MATRIX
                              **      CALLING SEQ:  CALL MULT(A,N1,N2,B,M1,M2,C)                    ** MATRIX
                              **                                                                    ** MATRIX
                              **      ARGUMENTS  :  A  - IN  - N1 BY N2 MATRIX                      ** MATRIX
                              **                    N1 - IN  - NUMBER OF ROWS IN A                  ** MATRIX
                              **                    N2 - IN  - NUMBER OF COLUMNS IN A               ** MATRIX
                              **                    B  - IN  - M1 BY M2 MATRIX                      ** MATRIX
                              **                    M1 - IN  - NUMBER OF ROWS IN B                  ** MATRIX
                              **                    M2 - IN  - NUMBER OF COLUMNS IN B               ** MATRIX
                              **                    C  - OUT - N1 BY M2 MATRIX                      ** MATRIX
                              **                                                                    ** MATRIX
                              **      NOTE       :  FORTRAN EQUIVALENT ROUTINE                      ** MATRIX
                              **                                                                    ** MATRIX
                              **                    SUBROUTINE MULT(A,N1,N2,B,M1,M2,C)              ** MATRIX
                              **                    DIMENSION A(N1,N2),B(M1,M2),C(N1,M2)            ** MATRIX
                              **                    DO 10 I=1,N1                                    ** MATRIX
                              **                    DO 10 J=1,M2                                    ** MATRIX
                              **                    C(I,J) = 0.0                                    ** MATRIX
                              **                    DO 10 K=1,M2                                    ** MATRIX
                              **                 10 C(I,J) = C(I,J) + A(I,K)*B(K,J)                 ** MATRIX
                              **                    RETURN                                          ** MATRIX
                              **                    END                                             ** MATRIX
                              **                                                                    ** MATRIX
                              ************************************************************************ MATRIX
    131                  1    MULT     BSS   1          ENTRY/EXIT                                     MATRIX
    132  6110000001                    SB1   1                                                         MATRIX
                   54211               SA2   A1+B1      PUT ADDRESS OF N1 INTO X2                      MATRIX
                         54321         SA3   A2+B1      PUT ADDRESS OF N2 INTO X3                      MATRIX
    133  54431                         SA4   A3+B1      PUT ADDRESS OF B(1,1) INTO X4                  MATRIX
              54541                    SA5   A4+B1      PUT ADDRESS OF M1 INTO X5                      MATRIX
                   53220               SA2   X2         PUT CONTENTS OF N1 INTO X2                     MATRIX
                         53330         SA3   X3         PUT CONTENTS OF N2 INTO X3                     MATRIX
    134  63220                         SB2   X2         MOVE N1 TO B2                                  MATRIX
              63330                    SB3   X3         MOVE N2 TO B3                                  MATRIX
                   54251               SA2   A5+B1      PUT ADDRESS OF M2 INTO X2                      MATRIX
                         54321         SA3   A2+B1      PUT ADDRESS OF C(1,1) INTO X3                  MATRIX
    135  53220                         SA2   X2         PUT CONTENTS OF M2 INTO X2                     MATRIX
              63420                    SB4   X2         MOVE M2 TO B4                                  MATRIX
                   76020               SX0   B2         MOVE N1 TO X0                                  MATRIX
                         66700         SB7   B0         COLUMN INCREMENT FOR *B*                       MATRIX
    136  66500                         SB5   B0         COLUMN INCREMENT FOR *C*                       MATRIX
    137                       LOOP.A   BSS   0                                                         MATRIX
    137  76770                         SX7   B7         MOVE J TO X7                                   MATRIX
              43600                    MX6   0          SET X6 TO ZERO                                 MATRIX
                   36747               IX7   X4+X7      PUT ADDRESS OF B(1,J) INTO X7                  MATRIX
                         63670         SB6   X7         MOVE ADDRESS OF B(1,J) TO B6                   MATRIX
    140  73710                         SX7   X1         PUT ADDRESS OF A(I,1) INTO X7                  MATRIX
    141                       LOOP.B   BSS   0                                                         MATRIX
    141  56260                         SA2   B6         PUT CONTENTS OF B(K,J) INTO X2                 MATRIX
              53570                    SA5   X7         PUT CONTENTS OF A(I,K) INTO X5                 MATRIX
                   40552               FX5   X5*X2      PUT A(I,K)*B(K,J) INTO X5                      MATRIX
                         66661         SB6   B6+B1      GET NEXT ELEMENT OF *B*                        MATRIX
    142  73772                         SX7   X7+B2      GET NEXT ELEMENT OF *A*                        MATRIX
              30665                    FX6   X6+X5      SUM INTO C(I,J)                                MATRIX
              24606                  NX6                NORMALIZE X6                                  MATRIX   641
                   67331             SB3      B3-B1     DECREMENT N2                                  MATRIX   642
  143  0703000141 +                  GT       B3,B0,LOOP.B                                            MATRIX   643
              53635                  SA6      X3+B5     STORE C(I,J)                                  MATRIX   644
                   66552             SB5      B5+B2     GET NEXT ELEMENT OF *C*                       MATRIX   645
  144  5021000002                    SA2      A1+2      PUT ADDRESS OF N2 INTO X2 AGAIN               MATRIX   646
              53220                  SA2      X2        PUT CONTENTS OF N2 X2 AGAIN                   MATRIX   647
                   63320             SB3      X2        MOVE N2 INTO B3 AGAIN                         MATRIX   648
  145  66773                         SB7      B7+B3     INCREMENT FOR NEXT COLUMN OF *B*              MATRIX   649
         67441                       SB4      B4-B1     DECREMENT M2                                  MATRIX   650
              0704000137 +           GT       B4,B0,LOOP.A                                            MATRIX   651
  146  5021000005                    SA2      A1+5      PUT ADDRESS OF M2 INTO X2                     MATRIX   652
              53220                  SA2      X2        PUT CONTENTS OF M2 INTO X2                    MATRIX   653
                   63420             SB4      X2        PUT M2 BACK INTO B4 AGAIN                     MATRIX   654
  147  7200777776                    SX0      X0-1      DECREMENT N1                                  MATRIX   655
              73111                  SX1      X1+B1     INCREMENT FOR NEXT ROW OF *A*                 MATRIX   656
                   73331             SX3      X3+B1     INCREMENT FOR NEXT ROW OF *C*                 MATRIX   657
  150  66500                         SB5      B0        RESET COLUMN INCREMENT FOR *C* TO ZERO        MATRIX   658
         66700                       SB7      B0        RESET COLUMN INCREMENT FOR *B* TO ZERO        MATRIX   659
              0310000137 +           NZ       X0,LOOP.A                                               MATRIX   660
  151  0400000131 +                  EQ       MULT      RETURN                                        MATRIX   661
```

```
                                 ********************************************************************* MATRIX    663
                                 **                                                                 ** MATRIX    664
                                 **      ROUTINE TO MULTIPLY AN N BY M MATRIX BY THE TRANSPOSE OF AN ** MATRIX    665
                                 **      L BY M MATRIX.                                             ** MATRIX    666
                                 **                                                                 ** MATRIX    667
                                 **      CALLING SEQ:  CALL MULTART(A,N1,N2,B,M1,M2,C)              ** MATRIX    668
                                 **                                                                 ** MATRIX    669
                                 **      ARGUMENTS  :  A  - IN  - N1 BY N2 MATRIX                   ** MATRIX    670
                                 **                    N1 - IN  - NUMBER CF ROWS IN A               ** MATRIX    671
                                 **                    N2 - IN  - NUMBER OF COLUMNS IN B            ** MATRIX    672
                                 **                    B  - IN  - M1 BY M2 MARIX                    ** MATRIX    673
                                 **                    M1 - IN  - NUMBER OF ROWS IN B               ** MATRIX    674
                                 **                    M2 - IN  - NUMBER OF COLUMNS IN B            ** MATRIX    675
                                 **                    C  - OUT - N1 BY M1 MATRIX                   ** MATRIX    676
                                 **                                                                 ** MATRIX    677
                                 **      NOTE       :  FORTRAN EQUIVALENT ROUTINE                   ** MATRIX    678
                                 **                                                                 ** MATRIX    679
                                 **                    SUBROUTINE MULTART(A,N1,N2,B,M1,M2,C)        ** MATRIX    680
                                 **                    DIMENSION A(N1,N2),B(M1,M2),C(N1,M1)         ** MATRIX    681
                                 **                    DO 1C I=1,N1                                 ** MATRIX    682
                                 **                    DO 1C J=1,M1                                 ** MATRIX    683
                                 **                    C(I,J) = C.0                                 ** MATRIX    684
                                 **                    DO 10 K=1,M2                                 ** MATRIX    685
                                 **                 10 C(I,J) = C(I,J) + A(I,K)*B(J,K)              ** MATRIX    686
                                 **                    RETURN                                       ** MATRIX    687
                                 **                    END                                          ** MATRIX    688
                                 **                                                                 ** MATRIX    689
                                 ********************************************************************* MATRIX    690
152                   1    MULTART  BSS   1          ENTRY/EXIT                                          MATRIX    691
153  6110000001                     SB1   1                                                              MATRIX    692
               54211                SA2   A1+B1      PUT ADDRESS OF N1 INTO X2                           MATRIX    693
                    54321           SA3   A2+B1      PUT ADDRESS OF N2 INTO X3                           MATRIX    694
154  54431                          SA4   A3+B1      PUT ADDRESS OF B(1,1) INTO X4                       MATRIX    695
          54541                     SA5   A4+B1      PUT ADDRESS OF M1 INTO X5                           MATRIX    696
               53220                SA2   X2         PUT N1 INTO X2                                      MATRIX    697
                    63220           SB2   X2         PUT N1 INTO B2                                      MATRIX    698
155  53350                          SA3   X5         PUT M1 INTO X3                                      MATRIX    699
          63330                     SB3   X3         PUT M1 INTO B3                                      MATRIX    700
               54351                SA3   A5+B1      PUT ADDRESS OF M2 INTO X3                           MATRIX    701
                    54531           SA5   A3+B1      PUT ADDRESS OF C(1,1) INTO X5                       MATRIX    702
156  53330                          SA3   X3         PUT M2 INTO X3                                      MATRIX    703
          63430                     SB4   X3         PUT M2 INTO B4                                      MATRIX    704
               76020                SX0   B2         PUT N1 INTO XC                                      MATRIX    705
                    66730           SB7   B3         LOOP COUNTER                                        MATRIX    706
157  66500                          SB5   B0         COLUMN INCREMENT FOR *C*                            MATRIX    707
160                        LOOP.C   BSS   0                                                              MATRIX    708
160  43600                          MX6   C          ZERO X6                                             MATRIX    709
          63640                     SB6   X4         PUT ADDRESS OF B(J,1) INTO B6                       MATRIX    710
               73710                SX7   X1         PUT ADDRESS OF A(I,1) INTO X7                       MATRIX    711
161                        LOOP.D   BSS   0                                                              MATRIX    712
161  56260                          SA2   B6         PUT CONTENTS OF B(J,K) INTO X2                      MATRIX    713
          53370                     SA3   X7         PUT CONTENTS CF A(I,K) INTO X3                      MATRIX    714
               40332                FX3   X3*X2      PUT A(I,K)*B(J,K) INTC X3                           MATRIX    715
                    66663           SB6   B6+B3      GET NEXT ELEMENT OF *B*                             MATRIX    716
162  73772                          SX7   X7+B2      GET NEXT ELEMENT OF *A*                             MATRIX    717
          30663                     FX6   X6+X3      SUM INTO C(I,J)                                     MATRIX    718
               24606                NX6              NORMALIZE X6                                        MATRIX    719
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                 67441                SB4    B4-B1          DECREMENT M2                                    MATRIX    720
  163  0704000161 +                   GT     B4,B0,LOOP.D                                                   MATRIX    721
            53655                     SA6    X5+A5          STORE C(I,J)                                    MATRIX    722
                 66552                SB5    B5+B2          GET NEXT ELEMENT OF *C*                         MATRIX    723
  164  5021000005                     SA2    A1+5           PUT ADDRESS OF M2 INTO X2                       MATRIX    724
            53220                     SA2    X2             PUT M2 INTO X2                                  MATRIX    725
                 63420                SB4    X2             PUT M2 INTO B4 AGAIN                            MATRIX    726
  165  67771                          SB7    B7-B1          DECREMENT LOOP COUNT                            MATRIX    727
       73441                          SX4    X4+B1          GET NEXT ROW ELEMENT OF*B*                      MATRIX    728
            0707000160 +              GT     B7,B0,LOOP.C                                                   MATRIX    729
  166  5041000003                     SA4    A1+3           PUT ADDRESS OF B(1,1) INTO X4 AGAIN             MATRIX    730
            73111                     SX1    X1+B1          INCREMENT FOR NEXT ROW OF *A*                   MATRIX    731
                 73551                SX5    X5+B1          INCREMENT FOR NEXT ROW OF *C*                   MATRIX    732
  167  66500                          SB5    B0             RESET COLUMN INCREMENT FOR *C* TO ZERO          MATRIX    733
       66730                          SB7    B3             RESET COLUMN INCREMENT FOR *B* TO ZERO          MATRIX    734
            7200777776                SX0    X0-1           DECREMENT N1                                    MATRIX    735
  170  0310000160 +                   NZ     X0,LOOP.C                                                      MATRIX    736
            0400000152 +              EQ     MULTABT        RETURN                                          MATRIX    737
```

```
                                **************************************************************************************** MATRIX
                                **                                                                                    ** MATRIX
                                **          ROUTINE TO MULTIPLY AN N BY M MATRIX BY A CONSTANT.                       ** MATRIX
                                **                                                                                    ** MATRIX
                                **          CALLING SEQ:  CALL MULTC(A,B,N,M,C)                                       ** MATRIX
                                **                                                                                    ** MATRIX
                                **          ARGUMENTS   :  A - IN  - SCALAR                                           ** MATRIX
                                **                         B - IN  - MATRIX                                           ** MATRIX
                                **                         N - IN  - NUMBER OF ROWS IN B                              ** MATRIX
                                **                         M - IN  - NUMBER OF COLUMNS IN B                           ** MATRIX
                                **                         C - OUT - RESULTANT MATRIX OF A*B                          ** MATRIX
                                **                                                                                    ** MATRIX
                                **          NOTE        :  FORTRAN EQUIVALENT ROUTINE                                 ** MATRIX
                                **                                                                                    ** MATRIX
                                **                         SUBROUTINE MULTC(A,B,N,M,C)                                ** MATRIX
                                **                         DIMENSION B(N,M),C(N,M)                                    ** MATRIX
                                **                         DO 10 J=1,M                                                ** MATRIX
                                **                         DO 10 I=1,N                                                ** MATRIX
                                **                      10 C(I,J) = A*B(I,J)                                          ** MATRIX
                                **                         RETURN                                                     ** MATRIX
                                **                         END                                                        ** MATRIX
                                **                                                                                    ** MATRIX
                                **************************************************************************************** MATRIX
 171                 1           MULTC      BSS     1          ENTRY/EXIT                                                MATRIX
 172  6110000001                            SB1     1                                                                    MATRIX
            54211                           SA2     A1+B1      PUT ADDRESS OF B(1,1) INTO X2                             MATRIX
                 54321                      SA3     A2+B1      PUT ADDRESS OF N INTO X3                                  MATRIX
 173  54431                                 SA4     A3+B1      PUT ADDRESS OF M INTO X4                                  MATRIX
            54541                           SA5     A4+B1      PUT ADDRESS OF C(1,1) INTO X5                             MATRIX
                 53110                      SA1     X1         PUT A INTO X1                                             MATRIX
                      53330                 SA3     X3         PUT N INTO X3                                             MATRIX
 174  53440                                 SA4     X4         PUT M INTO X4                                             MATRIX
            42734                           IX7     X3*X4      PUT N*M INTO X7                                           MATRIX
                 63270                      SB2     X7         MOVE N*M TO B2                                            MATRIX
 175                             LOOP.H     BSS     0                                                                    MATRIX
 175  53320                                 SA3     X2         PUT CONTENTS OF *B* INTO X3                               MATRIX
            40613                           FX6     X1*X3      PUT A*B INTO X6                                           MATRIX
                 53650                      SA6     X5         STORE *C*                                                 MATRIX
                      73221                 SX2     X2+B1      GET NEXT ELEMENT OF *B*                                   MATRIX
 176  73551                                 SX5     X5+B1      GET NEXT ELEMENT OF *C*                                   MATRIX
            67221                           SB2     B2-B1      DECREMENT N*M                                             MATRIX
                 0520000175 +               NZ      B2,LOOP.H                                                            MATRIX
 177  0400000171 +                          EQ      MULTC      RETURN                                                    MATRIX
```

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                            ************************************************************************** MATRIX
                            **                                                                      ** MATRIX
                            **          ROUTINE TO SUBTRACT AN N BY M MATRIX FROM ANOTHER N BY M    ** MATRIX
                            **          MATRIX.                                                     ** MATRIX
                            **                                                                      ** MATRIX
                            **          CALLING SEQ:  CALL SUB(A,B,N,M,C)                           ** MATRIX
                            **                                                                      ** MATRIX
                            **          ARGUMENTS  :  A - IN  - MATRIX                              ** MATRIX
                            **                        B - IN  - MATRIX TO BE SUBTRACTED FROM A      ** MATRIX
                            **                        N - IN  - NUMBER OF ROWS IN A AND B           ** MATRIX
                            **                        M - IN  - NUMBER OF COLUMNS IN A AND B        ** MATRIX
                            **                        C - OUT - RESULTANT MATRIX                    ** MATRIX
                            **                                                                      ** MATRIX
                            **          NOTE       :  FORTRAN EQUIVALENT ROUTINE                    ** MATRIX
                            **                                                                      ** MATRIX
                            **                        SUBROUTINE SUB(A,B,N,M,C)                     ** MATRIX
                            **                        DIMENSION A(N,M),B(N,M),C(N,M)                ** MATRIX
                            **                        DO 10 J=1,M                                   ** MATRIX
                            **                        DO 10 I=1,N                                   ** MATRIX
                            **                     10 C(I,J) = A(I,J) - B(I,J)                      ** MATRIX
                            **                        RETURN                                        ** MATRIX
                            **                        END                                           ** MATRIX
                            **                                                                      ** MATRIX
                            ************************************************************************** MATRIX
   200                1     SUB      BSS   1           ENTRY/EXIT                                      MATRIX
   201 6110000001                    SB1   1                                                           MATRIX
                 54211               SA2   A1+B1       PUT ADDRESS OF B(1,1) IN X2                     MATRIX
                      54321          SA3   A2+B1       PUT ADDRESS OF N IN X3                          MATRIX
   202 54431                         SA4   A3+B1       PUT ADDRESS OF M IN X4                          MATRIX
            54541                    SA5   A4+B1       PUT ADDRESS OF C(1,1) IN X5                     MATRIX
                 53330               SA3   X3          PUT N INTO X3                                   MATRIX
                      53440          SA4   X4          PUT M INTO X4                                   MATRIX
   203 42734                         IX7   X3*X4       N*M IN X7                                       MATRIX
                 63270               SB2   X7          MOVE N*M TO B2                                  MATRIX
   204                      LOOP.I   BSS   0                                                           MATRIX
   204 53310                         SA3   X1          GET NEXT ELEMENT OF *A*                         MATRIX
            53420                    SA4   X2          GET NEXT ELEMENT OF *B*                         MATRIX
                 31634               FX6   X3-X4       A-B INTO X6                                     MATRIX
                      24606          NX6               NORMALIZE X6                                    MATRIX
   205 53650                         SA6   X5          STORE *C*                                       MATRIX
            73111                    SX1   X1+B1       INCREMENT FOR NEXT ELEMENT OF *A*               MATRIX
                 73221               SX2   X2+B1       INCREMENT FOR NEXT ELEMENT OF *B*               MATRIX.
                      73551          SX5   X5+B1       INCREMENT FOR NEXT ELEMENT OF *C*               MATRIX
   206 67221                         SB2   B2-B1       DECREMENT N*M                                   MATRIX
            0520000204 +             NZ    B2,LOOP.I                                                   MATRIX
   207 0400000200 +                  EQ    SUB         RETURN                                          MATRIX
```

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                                   ********************************************************************** MATRIX    830
                                   **                                                                  ** MATRIX    831
                                   **        ROUTINE TO LAYIN A MATRIX INTO ANOTHER MATRIX AT A GIVEN ROW** MATRIX    832
                                   **        AND CCLUMN.                                               ** MATRIX    833
                                   **                                                                  ** MATRIX    834
                                   **        CALLING SEQ:  CALL LAYIN(A,I,J,NRA,B,NR,NC,ITL)           ** MATRIX    835
                                   **                                                                  ** MATRIX    836
                                   **        ARGUMENTS  :  A   - IN  - MATRIX                          ** MATRIX    837
                                   **                      I   - IN  - ROW IN A WHERE LAYIN IS TO BEGIN ** MATRIX    838
                                   **                      J   - IN  - COLUMN IN A WHERE LAYIN IS TO BEGIN* MATRIX    839
                                   **                      NRA - IN  - NUMBER OF ROWS IN A             ** MATRIX    840
                                   **                      B   - IN  - MATRIX TO BE LAYED INTO A       ** MATRIX    841
                                   **                      NR  - IN  - NUMBER OF ROWS IN B             ** MATRIX    842
                                   **                      NC  - IN  - NUMBER OF COLUMNS IN B          ** MATRIX    843
                                   **                      ITL - IN  - TYPE OF LAYIN                   ** MATRIX    844
                                   **                                  NEGATIVE - SUBTRACT B FROM A    ** MATRIX    845
                                   **                                  ZERO     - OVERLAY B IN A       ** MATRIX    846
                                   **                                  POSITIVE - ADD B TO A           ** MATRIX    847
                                   **                      A   - OUT - NEW MATRIX                      ** MATRIX    848
                                   **                                                                  ** MATRIX    849
                                   **        NOTE       :  EQUIVALENT FORTRAN ROUTINE                  ** MATRIX    850
                                   **                                                                  ** MATRIX    851
                                   **                      SUBRCUTINE LAYIN(A,I,J,NRA,B,NR,NC,ITL)     ** MATRIX    852
                                   **                      DIMENSION A(NRA,1),B(NR,NC)                 ** MATRIX    853
                                   **                      IF(ITL) 10,20,30                            ** MATRIX    854
                                   **                   10 DO 15 N=1,NC                                ** MATRIX    855
                                   **                      DO 15 M=1,NR                                ** MATRIX    856
                                   **                   15 A(I+M-1,J+N-1) = A(I+M-1,J+N-1) - B(M,N)    ** MATRIX    857
                                   **                      RETURN                                      ** MATRIX    858
                                   **                   20 DO 25 N=1,NC                                ** MATRIX    859
                                   **                      DO 25 M=1,NR                                ** MATRIX    860
                                   **                   25 A(I+M-1,J+N-1) = B(M,N)                     ** MATRIX    861
                                   **                      RETURN                                      ** MATRIX    862
                                   **                   30 DO 35 N=1,NC                                ** MATRIX    863
                                   **                      DO 35 M=1,NR                                ** MATRIX    864
                                   **                   35 A(I+M-1,J+N-1) = A(I+M-1,J+N-1) + B(M,N)    ** MATRIX    865
                                   **                      RETURN                                      ** MATRIX    866
                                   **                      END                                         ** MATRIX    867
                                   **                                                                  ** MATRIX    868
                                   ********************************************************************** MATRIX    869
        210                    1    LAYIN     BSS     1             ENTRY/EXIT                              MATRIX    870
        211  6110000001                       SB1     1                                                     MATRIX    871
                       63410                  SB4     X1            PUT ADDRESS OF A(1,1) IN B4             MATRIX    872
                            54211             SA2     A1+B1         PUT ADDRESS OF I INTO X2                MATRIX    873
        212  54321                            SA3     A2+B1         PUT ADDRESS OF J INTO X3                MATRIX    874
                  54431                       SA4     A3+B1         PUT ADDRESS OF NRA INTO X4              MATRIX    875
                       54541                  SA5     A4+B1         PUT ADDRESS OF B(1,1) INTO X5           MATRIX    876
                            53220             SA2     X2            PUT I INTO X2                           MATRIX    877
        213  63220                            SB2     X2            PUT I INTO B2                           MATRIX    878
                  53330                       SA3     X3            PUT J INTO X3                           MATRIX    879
                       63330                  SB3     X3            PUT J INTO B3                           MATRIX    880
                            53440             SA4     X4            PUT NRA INTO X4                         MATRIX    881
        214  54151                            SA1     A5+B1         PUT ADDRESS OF NR INTO X1               MATRIX    882
                  54211                       SA2     A1+B1         PUT ADDRESS OF NC INTO X2               MATRIX    883
                       54321                  SA3     A2+B1         PUT ADDRESS OF ITL INTO X3              MATRIX    884
                            53110             SA1     X1            PUT NR INTO X1                          MATRIX    885
        215  63610                            SB6     X1            PUT NR INTO B6                          MATRIX    886
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MATRIX - MISCELLANEOUS MATRIX OPERATIONS.                          COMPASS 3.3-428.      12/08/78  15.15.17.       PAGE    24
LAYIN - LAY A MATRIX INTO ANOTHER MATRIX

          53220                       SA2    X2          PUT NC INTO X2                            MATRIX   887
              63720                   SB7    X2          PUT NC INTO B7                            MATRIX   888
                  53330               SA3    X3          PUT ITL INTO X3                           MATRIX   889
   216  77021                         SX0    B2-B1       I-1                                       MATRIX   890
          77731                       SX7    B3-B1       J-1                                       MATRIX   891
              42774                   IX7    X7*X4       (J-1)*NRA                                 MATRIX   892
                  36007               IX0    X0+X7       (I-1)+(J-1)*NRA                           MATRIX   893
   217  73004                         SX0    X0+B4       PUT A(I,J) INTO X0                        MATRIX   894
          66400                       SB4    B0          ROW INCREMENT FOR *A*                     MATRIX   895
              63550                   SB5    X5          PUT ADDRESS OF B(1,1) IN B5               MATRIX   896
   220  0303000225 +                  ZR     X3,LOOP.F                                             MATRIX   897
              0333000231 +            NG     X3,LOOP.G                                             MATRIX   898
   221                         LOOP.E BSS    0                                                     MATRIX   899
   221  53304                         SA3    X0+B4       PUT A(I+M-1,J+N-1) IN X3                  MATRIX   900
          56554                       SA5    B5+B4       PUT B(M,N) IN X5                          MATRIX   901
              30635                   FX6    X3+X5       PUT A(I+M-1,J+N-1) + B(M,N) IN X6         MATRIX   902
                  24606               NX6                NORMALIZE X6                              MATRIX   903
   222  54630                         SA6    A3          STORE A(I+M-1,J+N-1)                      MATRIX   904
          66441                       SB4    B4+B1       INCREMENT M                               MATRIX   905
              0746000221 +            LT     B4,B6,LOOP.E                                          MATRIX   906
   223  36004                         IX0    X0+X4       INCREMENT FOR NEXT COLUMN OF *A*          MATRIX   907
          66556                       SB5    B5+B6       INCREMENT FOR NEXT COLUMN OF *B*          MATRIX   908
              66400                   SB4    B0          ZERO ROW INCREMENT                        MATRIX   909
                  67771               SB7    B7-B1       DECREMENT NC                              MATRIX   910
   224  0570000221 +                  NE     B7,B0,LOOP.E                                          MATRIX   911
              0400000210 +            EQ     LAYIN       RETURN                                    MATRIX   912
   225                         LOOP.F BSS    0                                                     MATRIX   913
   225  56554                         SA5    B5+B4       PUT B(M,N) IN X5                          MATRIX   914
          10655                       BX6    X5          MOVE B(M,N) TO X6                         MATRIX   915
              53604                   SA6    X0+B4       STORE A(I+M-1,J+N-1)                      MATRIX   916
                  66441               SB4    B4+B1       INCREMENT M                               MATRIX   917
   226  0746000225 +                  LT     B4,B6,LOOP.F                                          MATRIX   918
              36004                   IX0    X0+X4       INCREMENT FOR NEXT COLUMN OF *A*          MATRIX   919
                  66556               SB5    B5+B6       INCREMENT FOR NEXT COLUMN OF *B*          MATRIX   920
   227  66400                         SB4    B0          ZERO ROW INCREMENT                        MATRIX   921
          67771                       SB7    B7-B1       DECREMENT NC                              MATRIX   922
              0570000225 +            NE     B7,B0,LOOP.F                                          MATRIX   923
   230  0400000210 +                  EQ     LAYIN       RETURN                                    MATRIX   924
   231                         LOOP.G BSS    0                                                     MATRIX   925
   231  53304                         SA3    X0+B4       PUT A(I+M-1,J+N-1) IN X3                  MATRIX   926
          56554                       SA5    B5+B4       PUT B(M,N) IN X5                          MATRIX   927
              31635                   FX6    X3-X5       PUT A(I+M-1,J+N-1) - B(M,N) IN X6         MATRIX   928
                  24606               NX6                NORMALIZE X6                              MATRIX   929
   232  54630                         SA6    A3          STORE A(I+M-1,J+N-1)                      MATRIX   930
          66441                       SB4    B4+B1       INCREMENT M                               MATRIX   931
              0746000231 +            LT     B4,B6,LOOP.G                                          MATRIX   932
   233  36004                         IX0    X0+X4       INCREMENT FOR NEXT COLUMN OF *A*          MATRIX   933
          66556                       SB5    B5+B6       INCREMENT FOR NEXT COLUMN OF *B*          MATRIX   934
              66400                   SB4    B0          ZERO ROW INCREMENT                        MATRIX   935
                  67771               SB7    B7-B1       DECREMENT NC                              MATRIX   936
   234  0570000231 +                  NE     B7,B0,LOOP.G                                          MATRIX   937
              0400000210 +            EQ     LAYIN       RETURN                                    MATRIX   938
   235                                END                                                          MATRIX   939

              50100B CM  STORAGE USED             93E STATEMENTS        38 SYMBOLS
                         MODEL 74 ASSEMBLY      2.401 SECONDS          108 REFERENCES
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MATRIX - MISCELLANEOUS MATRIX OPERATIONS.                    COMPASS 3.3-428.     12/08/78  15.15.17.      PAGE    25
SYMBOLIC REFERENCE TABLE.

ADDNM          75      PROGRAM*        2/26 E    13/34 L    14/19
ADDNN         110      PROGRAM*        2/27 F    15/24 L    15/47
ADDTR         117      PROGRAM*        2/28 F    16/25 L    16/53
CODE.1         61      PROGRAM*       10/33      10/40      10/47 L
JMP.1         104      PROGRAM*       13/56      13/57      14/04 L
JMP.2         106      PROGRAM*       14/10      14/14 L
LAYIN         210      PROGRAM*        2/33 E    23/41 L    24/26      24/38      24/52
LOOP.A        137      PROGRAM*       17/45 L    18/11      18/20
LOOP.B        141      PROGRAM*       17/51 L    18/03
LOOP.C        160      PROGRAM*       19/46 L    20/10      20/17
LOOP.D        161      PROGRAM*       19/50 L    20/02
LOOP.E        221      PROGRAM*       24/13 L    24/20      24/25
LOOP.F        225      PROGRAM*       24/11      24/27 L    24/32      24/37
LOOP.G        231      PROGRAM*       24/12      24/39 L    24/46      24/51
LOOP.H        175      PROGRAM*       21/35 L    21/42
LOOP.I        204      PROGRAM*       22/35 L    22/45
LOOP.1          4      PROGRAM*        3/38 L     3/46
LOOP.10       114      PROGRAM*       15/36 L    15/46
LOOP.11       124      PROGRAM*       16/39 L    16/50
LOOP.12       123      PROGRAM*       16/35 L    16/52
LOOP.2         13      PROGRAM*        4/40 L     5/08       5/11      10/32      10/39
LOOP.3         15      PROGRAM*        4/51 L     5/03
LOOP.4         27      PROGRAM*        6/39 L     7/03       7/06
LOOP.5         30      PROGRAM*        6/46 L     6/56
LOOP.6         43      PROGRAM*        8/44 L     8/54       9/03       9/07
LOOP.7         65      PROGRAM*       11/33 L    11/57
LOOP.8         67      PROGRAM*       11/44 L    11/55
LOOP.9        102      PROGRAM*       13/52 L    14/18
MULT          131      PROGRAM*        2/29 E    17/28 L    18/21
MULTART       152      PROGRAM*        2/30 E    19/29 L    20/18
MULTC         171      PROGRAM*        2/31 E    21/24 L    21/43
MULTNN          7      PROGRAM*        2/21 E     4/27 L     5/12      10/38
MULTNNA        52      PROGRAM*        2/24 E    10/30 L    10/45
MULTNR          0      PROGRAM*        2/20 E     3/24 L     3/47
MULTNT         23      PROGRAM*        2/22 E     6/27 L     7/07
MULTTN         36      PROGRAM*        2/23 E     8/27 L     9/08
SUB           200      PROGRAM*        2/32 E    22/25 L    22/46
TRANNN         62      PROGRAM*        2/25 E    11/23 L    12/07
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      SUBROUTINE MISCAL(NPRNT)                                          MISCAL   2
C*********************************************************************** MISCAL   3
C*                                                                    * MISCAL   4
C*       SUBROUTINE FOR MISCELLANEOUS CALCULATIONS THAT DO NOT        * MISCAL   5
C*       NATURALLY OCCUR ELSEWHERE BUT ARE DESIRED FOR OUTPUT,        * MISCAL   6
C*       SUCH AS TABBING, PUNCHING, ETC., ETC.                        * MISCAL   7
C*                                                                    * MISCAL   8
C*    INPUT ARGUMENTS                                                 * MISCAL   9
C*       NPRNT      COVARIANCE MATRIX PRINT INDICATOR.                * MISCAL  10
C*                  0 = DO NOT PRINT MATRIX ON OUTPUT FILE.           * MISCAL  11
C*                                                                    * MISCAL  12
C*********************************************************************** MISCAL  13
      DIMENSION CA(48)                                                  MISCAL  14
C  *                                                                    R        2
C  ***      R ARRAY SEGMENT 1 - INTEGRATION VARIABLES.                  R        3
C  *                                                                    R        4
      COMMON TIME,TO,DTIME,DTOUT,DTOUT2,TMAX                            R        5
C  *                                                                    R        6
C  ***      R ARRAY SEGMENT 2 - DERIVATIVES.                            R        7
C  *                                                                    R        8
      COMMON UDOT,WDOT,QDOT,TDOT,XAPPDOT,ZAPPDOT,DFRPMD,XSPDOT,          R        9
     A       ZSPDOT,TSPDOT,                                             R       10
     B       VDOT,PDOT,RDOT,YAPPDOT,PHIDOT,PSIDOT,YSPDOT                R       11
C  *                                                                    R       12
C  ***      R ARRAY SEGMENT 3 - STATE VARIABLES.                        R       13
C  *                                                                    R       14
      COMMON UB,WB,QB,THETA,XAPP,ZAPP,DFRPM,XSP,ZSP,THETAS,             R       15
     A        VB,PB,RB,YAPP,PHI,PSI,YSP                                 R       16
C  *                                                                    R       17
C  ***      R ARRAY SEGMENT 4 - REF. VALUES FOR LOCAL LINEARIZATION.    R       18
C  *                                                                    R       19
      COMMON UO,WO,QO,THETAO,XAPPO,ZAPPO,XO,ZO,MO,UBASO,WBASO,WASDO,    R       20
     A       THETAAO,PSIAO,PHIAO,RCDO,VO,PO,RO,YAPPO,PHIO,PSIO,YO,LO,   R       21
     B       NO,VBASO                                                   R       22
      REAL   MO,LO,NO                                                   R       23
C  *                                                                    R       24
C  ***      R ARRAY SEGMENT 5 - INPUT FORCES AND MOMENTS.               R       25
C  *                                                                    R       26
      COMMON SUMFXO,SUMFZO,SUMMO,SUMFX,DFX,SUMFZ,DFZ,SUMM,DM,           R       27
     A       SUMFYO,SUMLO,SUMNO,SUMFY,DFY,SUML,DL,SUMN,DN                R       28
C  *                                                                    R       29
C  ***      R ARRAY SEGMENT 6 - GEOMETRY.                               R       30
C  *                                                                    R       31
      COMMON WEIGHT,G,IX,IY,IZ,IXZ,LM,WM,LTDM,LS,LTDS                   R       32
      REAL   G,IX,IY,IZ,IXZ,LM,LTDM,LS,LTDS                             R       33
C  *                                                                    R       34
C  ***      R ARRAY SEGMENT 7 - CONSTANTS.                              R       35
C  *                                                                    R       36
      COMMON  OMEGAU,OMEGAW,KU,KW,KFRPM,KCDN,TAUENG,TAUCON,TAUD,        R       37
     1         KDEU,KDEW,KDEQ,KDET,KDEX,KDEZ,KDEN,KDEDE,KDEDT,          R       38
     2         KDTU,KDTW,KDTQ,KDTT,KDTX,KDTZ,KDTN,KDTDE,KDTDT,          R       39
     3        OMEGAV,KV,TAUA,K1,K2,KY,B1,B2,TL1,TL2                     R       40
      REAL  KU,KW,KFRPM,KCDN,                                           R       41
     1      KDEU,KDEW,KDEQ,KDET,KDEX,KDEZ,KDEN,KDEDE,KDEDT,             R       42
     2      KDTU,KDTW,KDTQ,KDTT,KDTX,KDTZ,KDTN,KDTDE,KDTDT,             R       43
     3       K1,K2,KY,KV                                                R       44
C  *                                                                    R       45
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C  ***    R ARRAY SEGMENT 8 - WIND, ALTITUDE, AIRSPEED AND AIRWAKE.         R        46
C  *                                                                          R        47
      COMMON ALT,VAIR,UBAS,VBAS,WBAS,ALPHA,BETA,DUM1,DUM2,V5,PSI5,X1DWS,     R        48
     A       Y1DWS,VAMP,PSIAMP,X1DWA,Y1DWA,Z1DWA,VWOD,PSIWOD,PSI3,PSISP,     R        49
     B       PSIS,DX45,DY45,DZ45,XM,YM,ZM,PSIA,THETAA,PHIA,SIGMAVX,          R        50
     C       SIGMAVY,SIGMAVZ,VXAW,VYAW,VZAW,UWIND,UMEAN,UR,UAW,VWIND,        R        51
     D       VMEAN,VR,VAW,WWIND,WMEAN,WR,WAW,WNSF,PSISS,PSISC,PSIST,TS1,     R        52
     E       TS2,TS3,TS4,TS5,TR1,DXM145,DXM245,DYM145,DYM245,ZGSP,           R        53
     F       ZBIASP                                                          R        54
C  *                                                                          R        55
C  ***    R ARRAY SEGMENT 9 - OPEN LOOP PARAMETERS.                          R        56
C  *                                                                          R        57
      COMMON THETAC,DFRFMOL,DCDNOL,DEOL,GAMMAGS,RANGE,VAIRC,                 R        58
     1       DAOL,DROL                                                       R        59
C  *                                                                          R        60
C  ***    R ARRAY SEGMENT 10 - AERO DATA.                                    R        61
C  *                                                                          R        62
      COMMON XU,XW,XO,XFRPM,XCDN,XPDIGV,XDE,ZU,ZW,ZC,ZFRPM,ZCDN,ZPDIGV,      R        63
     A       ZDE,MU,MW,MWDOT,MO,MFRPM,MCDN,MPDIGV,MDE,                       R        64
     B         YV,YP,YR,YDA,YDR,LV,LP,LR,LDA,LDR,NV,NP,NR,                   R        65
     C         NDA,NDR                                                       R        66
      REAL    MU,MW,MWDOT,MO,MFRPM,MCDN,MPDIGV,MDE                           R        67
      REAL  LV,LP,LR,LDA,LDR,NV,NP,NR,NDA,NDR                                R        68
C  *                                                                          R        69
C  ***    R ARRAY SEGMENT 11                                                 R        70
C  *                                                                          R        71
      COMMON  RC,RCD,XAPCOM,ERRX,ERRU,        ERRZ,ERRW, ETHETA,             R        72
     1         ERY,ERPHI,ERPSI,YCOM,PHICOM,PSICOM                            R        73
C  *                                                                          R        74
C  ***    R ARRAY SEGMENT 12 - CONTROLS.                                     R        75
C  *                                                                          R        76
      COMMON  DE,DT,DCDN,DED,DTD,DCDND,                                      R        77
     1         DA,DR,DAP,DRP,DA1,DA2,DR1,DR2,DA1D,DA2D,DR1D,DR2D             R        78
C  *                                                                          R        79
C  ***    R ARRAY SEGMENT 13 - SPEED TABLE FOR AERO TABLE LOOKUPS.           R        80
C  *                                                                          R        81
      COMMON TABV1(6)                                                        R        82
C  *                                                                          R        83
C  ***    R ARRAY SEGMENT 14 -  TIME TABLE FOR OPEN LOOP COMMAND TABLE L     R        84
C  *                                                                          R        85
      COMMON TABV2(10)                                                       R        86
C  *                                                                          R        87
C  ***    R ARRAY SEGMENT 15 - UNUSED                                        R        88
C  *                                                                          R        89
C  *                                                                          R        90
C  ***    R ARRAY SEGMENT 16 - GDF RELATED STUFF                             R        91
C  *                                                                          R        92
      COMMON SIGDAP, SIGDRP, SIGDA, SIGDR, GAINDA, GAINDR                    R        93
C  *                                                                          R        94
C  ***    R ARRAY SEGMENT 17 - SHIP MOTION                                   R        95
C  *                                                                          R        96
      COMMON KXS,ZETAXS,WNXS,KZS,ZETAZS,WNZS,KTS,ZETATS,WNTS,                R        97
     1       KYS,ZETAYS,WNYS,KRS,ZETARS,WNRS,KPS,ZETAPS,WNPS,TAUPRT          R        98
      REAL KXS,KZS,KTS,KYS,KRS,KPS                                           R        99
C  *                                                                          R       100
C  ***    R ARRAY SEGMENTS 20-23 - OPEN LOOP COMMAND TABLES.                 R       101
C  *                                                                          R       102
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      COMMON TABTC(10)                                                  R   103
      COMMON TRPMCL(10)                                                 R   104
      COMMON TCONOL(10)                                                 R   105
      COMMON TDEOL(10)                                                  R   106
C *                                                                     R   107
C ***     R ARRAY SEGMENTS 24-25                                        R   108
C *                                                                     R   109
      COMMON TABR(10)                                                   R   110
      COMMON TABRDOT(10)                                                R   111
C *                                                                     R   112
C ***     R ARRAY SEGMENTS 27-48 - LONGITUDINAL AERO DATA TABLES        R   113
C *                                                                     R   114
      COMMON TXU(6)                                                     R   115
      COMMON TXW(6)                                                     R   116
      COMMON TXQ(6)                                                     R   117
      COMMON TXRPM(6)                                                   R   118
      COMMON TXCON(6)                                                   R   119
      COMMON TXPIGV(6)                                                  R   120
      COMMON TXDE(6)                                                    R   121
      COMMON TZU(6)                                                     R   122
      COMMON TZW(6)                                                     R   123
      COMMON TZQ(6)                                                     R   124
      COMMON TZPPM(6)                                                   R   125
      COMMON TZCON(6)                                                   R   126
      COMMON TZPIGV(6)                                                  R   127
      COMMON TZDE(6)                                                    R   128
      COMMON TMU(6)                                                     R   129
      COMMON TMW(6)                                                     R   130
      COMMON TMWD(6)                                                    R   131
      COMMON TMQ(6)                                                     R   132
      COMMON TMRPM(6)                                                   R   133
      COMMON TMCON(6)                                                   R   134
      COMMON TMPIGV(6)                                                  R   135
      COMMON TMDE(6)                                                    R   136
C *                                                                     R   137
C ***     R ARRAY SEGMENTS 50-54 - COVARIANCE MATRICIES (DO NOT OVERDIME R   138
C *                                                                     R   139
      COMMON  F(17,17),P(17,17),PDOT(17,17),GM(11,4),QM(4,4)            R   140
C *                                                                     R   141
C ***     R ARRAY SEGMENTS 55-56 - STANDARD DEVIATIONS.                 R   142
C *                                                                     R   143
      COMMON SIGMA(50)                                                  R   144
      COMMON SIGMAXY(50)                                                R   145
C *                                                                     R   146
C ***     R ARRAY SEGMENTS 57-62 - AIRWAKE TABLES                       R   147
C *                                                                     R   148
      COMMON VXX(5,5,3)                                                 R   149
      COMMON VYY(5,5,3)                                                 R   150
      COMMON VZZ(5,5,3)                                                 R   151
      COMMON SVXX(5,5,3)                                                R   152
      COMMON SVYY(5,5,3)                                                R   153
      COMMON SVZZ(5,5,3)                                                R   154
C *                                                                     R   155
C ***     R ARRAY SEGMENTS 63-80 - OPTIMAL CONTROLLER GAINS             R   156
C *                                                                     R   157
      COMMON  TKDEL(6), TKDEW(6), TKDEQ(6), TKDET(6), TKDEX(6),         R   158
     1        TKDEZ(6), TKDEM(6), TKDEDF(6), TKDEDT(6),                 R   159
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        2       TKDTU(6), TKDTW(6), TKDTO(6), TKDTT(6), TKDTX(6),              R          160
        3       TKDTZ(6), TKDTN(6), TKDTDE(6), TKDTDT(6)                       R          161
      C  *                                                                     R          162
      C  ***    R ARRAY SEGMENTS 81-106                                        R          163
      C  *                                                                     R          164
         COMMON F1(6,6),G1(6,4),GAMMA(6,7),A(7,7),B(7,4),M1(1,1),M2(1,1),      R          165
        1      H(1,1),D(1,1),C(4,6),RL(4,4),W(1,1),VU(1,1),VY(1,1),            R          166
        2      VYI(1,1),S(1,1),FE(1,1),CF(1,1),PE(1,1),PFD(1,1),               R          167
        3      KG(1,1),FXHAT(1,1),PXHAT(1,1),FXHATD(1,1),PX(1,1),              R          168
        4      CS(1,1)                                                         R          169
         REAL M1,M2,KG                                                         R          170
      C  *                                                                     R          171
      C  ***    R ARRAY SEGMENT 107 - MORE OPTIMAL CONTROLLER GAINS (NOISE REL R          172
      C  *                                                                     R          173
         COMMON  DFUR, DEWR, DFVX, DEVXD, DEVZ, DFVZD,                         R          174
        1        DTUR, DTWR, DTVX, DTVXD, DTVZ, DTVZD                          R          175
      C  *                                                                     R          176
      C  ***    R ARRAY SEGMENTS 108-119                                       R          177
      C  *                                                                     R          178
         COMMON  TDEUR(6), TDEWR(6), TDEVX(6), TDEVXD(6), TDEVZ(6),            R          179
        1        TDEVZD(6),  TDTUR(6), TDTWR(6), TDTVX(6), TDTVXD(6),          R          180
        2        TDTVZ(6), TDTVZD(6)                                           R          181
      C  *                                                                     R          182
      C  ***    R ARRAY SEGMENTS 120-134 - LAT/DIR AERO DATA TABLES            R          183
      C  *                                                                     R          184
         COMMON  TYV(6), TYP(6), TYR(6), TYDA(6), TYDR(6),                     R          185
        1        TLV(6), TLP(6), TLR(6), TLDA(6), TLDR(6),                     R          186
        2        TNV(6), TNP(6), TNR(6), TNDA(6), TNDR(6)                      R          187
      C  *                                                                     R          188
      C  ***    R ARRAY SEGMENTS 135-139 - LONG. TERMS REQD FOR LAT/DIR CASE   R          189
      C  *                                                                     R          190
         COMMON  TARUB(10),TARWB(10),TXAPP(10),TZAPP(10),TXSP(10)              R          191
      C  *                                                                     R          192
      C  ***    R ARRAY SEGMENTS 140-143 - TABLES OF NONLINEAR FUNCTIONS       R          193
      C  *                                                                     R          194
         COMMON TDAIN(4), TDAOUT(4), TDRIN(4),TDROUT(4)                        R          195
      C  ****************************************************************    C R          196
      C  *                                                                     I            2
      C  ***    I ARRAY SEGMENT 1 - INTEGER VARIABLES.                         I            3
      C  *                                                                     I            4
         COMMON/INTEGER/ICEES,NEQU,NSTATES,NFA,NQM,NGM,NPE,NPX,NQAW,NQINIT     I            5
      C  *                                                                     I            6
      C  ***    I ARRAY SEGMENT 4 - DERIVATIVE INDICES.                        I            7
      C                                                                        I            8
         COMMON/INTEGER/ INDX1(14)                                             I            9
      C  *                                                                     I           10
      C  ***    I ARRAY SEGMENT 5 - STATE INDICES.                             I           11
      C  *                                                                     I           12
         COMMON/INTEGER/ INDX2(14)                                             I           13
      C  *                                                                     I           14
      C  ***    I ARRAY SEGMENT 6 - VARIOUS INDICES.                           I           15
      C  *                                                                     I           16
         COMMON/INTEGER/ INDXPD,INDXP,INDXPEL,INDXPE,INDXPXD,INDXPX            I           17
      C   **************************************************************     C I           18
      C********************************************************************* MISCAL       17
      C*                                                                   * MISCAL       18
      C*        SIGMAS OF STATE VARIABLES AND OTHER TERMS.                 * MISCAL       19
      C*.                                                                      * MISCAL     20
      C************************************************************************* MISCAL     21
      C  *                                                                       MISCAL     22
      C  ***     STATE VARIABLES.                                                MISCAL     23
      C  *                                                                       MISCAL     24
            DO 10 I=1,NPA                                                        MISCAL     25
            SIGMA(I)= SQRT(P(I,I))                                               MISCAL     26
            CA(I)   = 0.0                                                        MISCAL     27
      10    CONTINUE                                                             MISCAL     28
            L = NPA                                                              MISCAL     29
            IF(NPRNT.EQ.0) GO TO 30                                              MISCAL     30
      C  ***    PRODUCE REQUESTED PRINT.                                         MISCAL     31
            WRITE(6,2000) TIME                                                   MISCAL     32
      2000  FORMAT(1H1,47X,27HCOVARIANCE MATRIX AT TIME =,F6.2,5H SEC.     //)   MISCAL     33
            DO 20 I=1,NPA                                                        MISCAL     34
            WRITE(6,2010) (P(I,J),J=1,NPA)                                       MISCAL     35
      2010  FORMAT(1X,8F16.6)                                                    MISCAL     36
            WRITE(6,2020)                                                        MISCAL     37
      2020  FORMAT(/)                                                            MISCAL     38
      20    CONTINUE                                                             MISCAL     39
            WRITE(6,2030) (SIGMA(I),I=1,NPA)                                     MISCAL     40
      2030  FORMAT(//35H SQUARE ROOT OF MAIN DIAGONAL TERMS     ,                MISCAL     41
           1     /(8E12.4))                                                      MISCAL     42
        30  CONTINUE                                                             MISCAL     43
      C  *                                                                       MISCAL     44
      C  ***      SIGMAS OF NON-LIMITED ROLL AND YAW CONTROL                     MISCAL     45
      C  *                                                                       MISCAL     46
      C     ROLL                                                                 MISCAL     47
            L       = L + 1                                                      MISCAL     48
            SIGMA(L)= SIGDAP                                                     MISCAL     49
      C     YAW                                                                  MISCAL     50
            L       = L + 1                                                      MISCAL     51
            SIGMA(L)= SIGDRP                                                     MISCAL     52
      C  *                                                                       MISCAL     53
      C  ***      SIGMAS OF ROLL AND YAW CONTROL AFTER LIMITERS                  MISCAL     54
      C  *                                                                       MISCAL     55
      C     ROLL                                                                 MISCAL     56
            L        = L + 1                                                     MISCAL     57
            SIGMA(L) = SIGDA                                                     MISCAL     58
      C     YAW                                                                  MISCAL     59
            L        = L + 1                                                     MISCAL     60
            SIGMA(L) = SIGDR                                                     MISCAL     61
      C************************************************************************  MISCAL     62
      C*                         END OF SIGMA HACK                            *  MISCAL     63
      C************************************************************************  MISCAL     64
      C                                                                          MISCAL     65
      C                                                                          MISCAL     66
            RETURN                                                               MISCAL     67
            END                                                                  MISCAL     68
      SUBROUTINE PRNPLT(ROW,NLIST,NPRNT)                                 PRNPLT   2
C************************************************************************ PRNPLT   3
C*                                                                      * PRNPLT   4
C*         ROUTINE TO PRODUCE PLOT ON PRINTER (6600 DEPENDENT).         * PRNPLT   5
C*                                                                      * PRNPLT   6
C*    INPUT ARGUMENTS                                                   * PRNPLT   7
C*         ROW        SCRATCH ARRAY FOR READING DATA FILE.              * PRNPLT   8
C*         NLIST      FILE WHERE PLOTTING INSTRUCTIONS RESIDE.          * PRNPLT   9
C*         NPRNT      =0 IF INSTRUCTIONS ARE NOT TO BE PLAYED BACK ON   * PRNPLT  10
C*                    THE OUTPUT FILE.                                  * PRNPLT  11
C*                                                                      * PRNPLT  12
C*    DEFINITIONS                                                       * PRNPLT  13
C*         LINE       PLOTTING ARRAY.                                   * PRNPLT  14
C*         NPLOTS     NUMBER OF PLOTS TO BE PRODUCED.                   * PRNPLT  15
C*                                                                      * PRNPLT  16
C*    DEFINITIONS FOR PLOT DATA                                         * PRNPLT  17
C*         DELX       INCREMENTS PER INCH ON X AXIS.                    * PRNPLT  18
C*         DELY       INCREMENTS PER INCH ON Y AXIS.                    * PRNPLT  19
C*         LABELX     X AXIS LABEL.                                     * PRNPLT  20
C*         LABELY     Y AXIS LABEL.                                     * PRNPLT  21
C*         NCURVS     NUMBER OF CURVS TO BE PRODUCED ON THIS PLOT.      * PRNPLT  22
C*         STARTX     X VALUE AT AXIS INTERSECTION.                     * PRNPLT  23
C*         STARTY     Y VALUE AT AXIS INTERSECTION.                     * PRNPLT  24
C*         TITLE      PLOT TITLE.                                       * PRNPLT  25
C*         XORG       NUMBER OF INCHES FROM LEFT TO PLACE *STARTX*.     * PRNPLT  26
C*         YORG       NUMBER OF INCHES FROM TOP TO PLACE *STARTY*.      * PRNPLT  27
C*                                                                      * PRNPLT  28
C*    DEFINITIONS FOR CURVE DATA.                                       * PRNPLT  29
C*         ISYM       PLOTTING SYMBOL FOR THIS CURVE.                   * PRNPLT  30
C*         LEGEND     CURVE LEGEND NOTATION.                            * PRNPLT  31
C*         NCOLX      COLUMN ON DATA FILE WHERE X DATA RESIDE.          * PRNPLT  32
C*         NCOLY      COLUMN ON DATA FILE WHERE Y DATA RESIDE.          * PRNPLT  33
C*         NDATA      FILE WHERE DATA FOR X AND Y RESIDE.               * PRNPLT  34
C*         SCALEX     SCALE FACTOR FOR X DATA.                          * PRNPLT  35
C*         SCALEY     SCALE FACTOR FOR Y DATA.                          * PRNPLT  36
C*                                                                      * PRNPLT  37
C************************************************************************ PRNPLT  38
      DIMENSION ROW(1),TITLE(24),LEGEND(4),LINE(7,36),LABELX(4),         PRNPLT  39
     A           LABELY(4),X(7)                                          PRNPLT  40
      IF(NLIST.NE.5) REWIND NLIST                                        PRNPLT  41
      READ(NLIST,1000) NPLOTS                                            PRNPLT  42
 1000 FORMAT(I5)                                                         PRNPLT  43
      IF(NPRNT.GT.0) WRITE(6,2000) NPLOTS                                PRNPLT  44
 2000 FORMAT(//5X,I5)                                                    PRNPLT  45
C                                                                       C PRNPLT  46
C**************              READ PLOT DATA             **************C PRNPLT  47
C                                                                       C PRNPLT  48
      DO 140 I=1,NPLOTS                                                  PRNPLT  49
      READ(NLIST,1010) TITLE                                             PRNPLT  50
 1010 FORMAT(8A10)                                                       PRNPLT  51
      IF(NPRNT.GT.0) WRITE(6,2010) TITLE                                 PRNPLT  52
 2010 FORMAT(5X,8A10)                                                    PRNPLT  53
      IF(NPRNT.EQ.0) WRITE(6,30001)TITLE                                 PRNPLT  54
30001 FORMAT(1H1////5X,8A10//5X,8A10//5X,8A10///)                        PRNPLT  55
      READ(NLIST,1020) NCURVS,XORG,YORG,DELX,DELY,STARTX,STARTY          PRNPLT  56
 1020 FORMAT(I5,5X,6E10.3)                                               PRNPLT  57
      IF(NPRNT.GT.0) WRITE(6,2020) NCURVS,XORG,YORG,DELX,DELY,STARTX,    PRNPLT  58
     1                                 STARTY
2020  FORMAT(5X,I5,5X,6F10.4)
      READ(NLIST,1010) LABELX,LABELY
      IF(NPRNT.GT.0) WRITE(6,2010) LABELX,LABELY
      NLO          = IFIX(5.0*YORG) + 1
      NCO          = IFIX(10.0*XORG) + 1
C                                                                      C
C**************             PLOT Y AND Y AXES             **************C
C                                                                      C
      DO 20 J=1,36
      DO 10 K=1,7
      LINE(K,J)    = 10H
10    CONTINUE
20    CONTINUE
      DO 30 K=1,7
      LINE(K,NLO) = 10H..........
30    CONTINUE
      K            = (NCO + 9)/10
      L            = 10H
      J            = 10*K - NCO
      L            = L.AND.SHIFT(MASK(54),6*J)
      L            = L.OR.SHIFT(1R.,6*J)
      DO 40 J=1,36
      IF(J.NE.NLO) LINE(K,J) = L
40    CONTINUE
C                                                                      C
C**************           READ AND PLOT CURVES            **************C
C                                                                      C
      DO 70 J=1,NCURVS
      READ(NLIST,1030) LEGEND,NDATA,NCOLX,NCOLY,ISYM,SCALEX,SCALEY
1030  FORMAT(4A10,3I5,2X,R1,2X,2E10.3)
      IF(NPRNT.GT.0) WRITE(6,2030) LEGEND,NDATA,NCOLY,NCOLY,ISYM,SCALEX,
     1                         SCALEY
2030  FORMAT(5X,4A10,3I5,2X,R1,2X,2F12.5)
      IF(NPRNT.EQ.0) WRITE(6,30002) ISYM,LEGEND
30002 FORMAT(60X,R1,5X,4A10)
      REWIND NDATA
      READ(NDATA) L,NCOL,K
      IF(K.EQ.0) GO TO 50
      READ(NDATA) (ROW(K),K=1,NCOL)
      L            = IFIX(ROW(NCOLX) + 0.001)
50    XDUM1        = 10.0/DELX
      XDUM2        = 5.0/DELY
      IF(SCALEX.NE.0.0) XDUM1 = SCALEX*XDUM1
      IF(SCALEY.NE.0.0) XDUM2 = SCALEY*XDUM2
      DO 60 K=1,L
      READ(NDATA) (ROW(LL),LL=1,NCOL)
      NC           = NCO + IFIX(XDUM1*(ROW(NCOLX) - STARTX))
      NL           = NLO - IFIX(XDUM2*(ROW(NCOLY) - STARTY))
      IF(NC.LT.1.OR.NL.LT.1.OR.NC.GT.61.OR.NL.GT.36) GO TO 60
      LL           = (NC + 9)/10
      NC           = 10*LL - NC
      LINE(LL,NL) = LINE(LL,NL).AND.SHIFT(MASK(54),6*NC)
      LINE(LL,NL) = LINE(LL,NL).OR.SHIFT(ISYM,6*NC)
60    CONTINUE
70    CONTINUE
      IF(NPRNT.EQ.0) GO TO 100
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                WRITE(6,30001) TITLF                                           PRNPLT    116
                DC 80 J=1,NCURVS                                               PKNPLT    117
                HACKSPACE NLIST                                                PPNPLT    118
         80     CCNTINUE                                                       PKNPLT    119
                DO 90 J=1,NCURVS                                               PRNPLT    120
                READ(NLIST,1040) LEGEND,ISYM                                   PFNPLT    121
         1040   FORMAT(4A10,17X,R1)                                            PRNPLT    122
                WRITE(6,30002) ISYM,LEGEND                                     PPNPLT    123
         90     CCNTINUE                                                       PFNPLT    124
         100    WRITE(6,30003)                                                 PKNPLT    125
         30003  FORMAT(//)                                                     PKNPLT    126
         C                                                                   C PRNPLT    127
         C**************             PUT PLOT ON PRINTER        **************C PKNPLT    128
         C                                                                   C PRNPLT    129
                Y                  = STARTY + DELY*(YOPG + 1.0)                PFNPLT    130
                K                  = 0                                         PKNPLT    131
                DO 120 J=1,36                                                  PRNPLT    132
                K                  = K + 1                                     PFNPLT    133
                IF(K.GE.6) K = 1                                               PFNPLT    134
                 NC = 10H                                                      PFNPLT    135
                IF(J.GE.14.AND.J.LE.17) NC = LABELY(J-13)                      PRNPLT    136
                IF(K.GT.1) GO TO 110                                           PKNPLT    137
                Y                  = Y - DELY                                  PFNPLT    138
                WRITE(6,30004) NC,Y,(LINE(LL,J),LL=1,7)                        PFNPLT    139
         30004  FORMAT(5X,A10,2X,F5.2,1X,6A10,A1)                              PFNPLT    140
                GC TO 120                                                      PPNPLT    141
         110    WRITE(6,30005) NC,(LINE(LL,J),LL=1,7)                          PRNPLT    142
         30005  FORMAT(5X,A10,8X,6A10,A1)                                      PRNPLT    143
         120    CCNTINUE                                                       PRNPLT    144
                X(1)               = STARTX - XOPG*DELX                        PRNPLT    145
                DO 130 J=2,7                                                   PRNPLT    146
                X(J)               = X(J-1) + DELX                             PFNPLT    147
         130    CCNTINUE                                                       PRNPLT    148
                WRITE(6,30006) X                                               PRNPLT    149
         30006  FORMAT(/21X,7(F4.1,6X)//)                                      PPNPLT    150
                WRITE(6,30007) LABELX                                          PRNPLT    151
         30007  FORMAT(34X,4A10)                                               PRNPLT    152
                WRITE(6,30003)                                                 PRNPLT    153
         140    CONTINUE                                                       PPNPLT    154
                RETURN                                                         PRNPLT    155
                END                                                            PRNPLT    156
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      SUBROUTINE PROP                                                   PROP      2
C     ******************************************************************PROP      3
C     ***                                                               PROP      4
C     ***      ROUTINE TO CALCULATE PERTUBATION EQNS AND PROPAGATE COVARIANCE PROP  5
C     ***                                                               PROP      6
C     ******************************************************************PROP      7
      DIMENSION  WK2(4,11), G2(11,11)                                   PROP      8
C     *                                                                 R         2
C     ***      R ARRAY SEGMENT 1 - INTEGRATION VARIABLES.               R         3
C     *                                                                 R         4
      COMMON TIME,TC,DTIME,DTOUT,DTOUT2,TMAX                            R         5
C     *                                                                 R         6
C     ***      R ARRAY SEGMENT 2 - DERIVATIVES.                         R         7
C     *                                                                 R         8
      COMMON UDOT,WDOT,QDOT,TDOT,XAPPDOT,ZAPPDOT,DFRPMD,YSPDOT,         R         9
     A        ZSPDOT,TSPDOT,                                            R        10
     B        VDOT,PBDOT,RBDOT,YAPPDOT,PHIDOT,PSIDOT,YSPDOT             R        11
C     *                                                                 R        12
C     ***      R ARRAY SEGMENT 3 - STATE VARIABLES.                     R        13
C     *                                                                 R        14
      COMMON UB,WB,QB,THETA,XAPP,ZAPP,DFRPM,XSP,ZSP,THETAS,             R        15
     A          VB,PB,RB,YAPP,PHI,PSI,YSP                               R        16
C     *                                                                 R        17
C     ***      R ARRAY SEGMENT 4 - REF. VALUES FOR LOCAL LINEARIZATION. R        18
C     *                                                                 R        19
      COMMON UO,WO,QO,THETAO,XAPPO,ZAPPO,XC,ZO,MO,UBASO,WBASO,WASDO,    R        20
     A        THETAAO,PSIAO,PHIAO,PCDO,VO,PO,RO,YAPPC,PHIO,PSIO,YO,LO,  R        21
     B        NO,VBASO                                                  R        22
      REAL    MO,LO,NO                                                  R        23
C     *                                                                 R        24
C     ***      R ARRAY SEGMENT 5 - INPUT FORCES AND MOMENTS.            R        25
C     *                                                                 R        26
      COMMON SUMFXO,SUMFZO,SUMMO,SUMFX,DFX,SUMFZ,DFZ,SUMM,DM,           R        27
     A        SUMFYO,SUMLO,SUMNO,SUMFY,DFY,SUML,DL,SUMN,DN              R        28
C     *                                                                 R        29
C     ***      R ARRAY SEGMENT 6 - GEOMETRY.                            R        30
C     *                                                                 R        31
      COMMON WEIGHT,G,IX,IY,IZ,IXZ,LM,WM,LTDM,LS,LTDS                   R        32
      REAL   G,IX,IY,IZ,IXZ,LM,LTDM,LS,LTDS                             R        33
C     *                                                                 R        34
C     ***      R ARRAY SEGMENT 7 - CONSTANTS.                           R        35
C     *                                                                 R        36
      COMMON  OMEGAU,OMEGAW,KU,KW,KFRPM,KCON,TAUENG,TAUCON,TAUD,        R        37
     1         KDEU,KDEW,KDEQ,KDET,KDEX,KDEZ,KDEN,KDEDE,KDEDT,          R        38
     2         KDTU,KDTW,KDTQ,KDTT,KDTX,KDTZ,KDTN,KDTDE,KDTDT,          R        39
     3        OMEGAV,KV,TAUA,K1,K2,KY,B1,B2,TL1,TL2                     R        40
      REAL KU,KW,KFRPM,KCON,                                            R        41
     1         KDEU,KDEW,KDEQ,KDET,KDEX,KDEZ,KDEN,KDEDE,KDEDT,          R        42
     2         KDTU,KDTW,KDTQ,KDTT,KDTX,KDTZ,KDTN,KDTDE,KDTDT,          R        43
     3         K1,K2,KY,KV                                              R        44
C     *                                                                 R        45
C     ***      R ARRAY SEGMENT 8 - WIND, ALTITUDE, AIRSPEED AND AIRWAKE. R       46
C     *                                                                 R        47
      COMMON ALT,VAIR,UBAS,VBAS,WBAS,ALPHA,BETA,DUM1,DUM2,V5,PSI5,X1DWS, R       48
     A          Y1DWS,VAMB,PSIAMB,X1DWA,Y1DWA,Z1DWA,VWOD,PSIWOD,PSI3,PSISP, R    49
     B          PSIS,DX45,DY45,DZ45,XM,YM,ZM,PSIA,THETAA,PHIA,SIGMAVX,  R        50
     C          SIGMAVY,SIGMAVZ,VXAW,VYAW,VZAW,UWIND,UMEAN,UR,UAW,VWIND, R       51
     D        VMEAN,VP,VAW,WWIND,WMEAN,WR,WAW,WNSF,PSISS,PSISC,PSIST,TS1,  R       52
     E        TS2,TS3,TS4,TS5,TR1,DXM145,DXM245,DYM145,DYM245,ZGSP,       R       53
     F        ZBIASP                                                      R       54
C  *                                                                      R       55
C  ***    R ARRAY SEGMENT 9 - OPEN LOOP PARAMETERS.                       R       56
C  *                                                                      R       57
      COMMON THETAC,DFRPMOL,DCONOL,DEOL,GAMMAGS,RANGE,VAIRC,              R       58
     1        DAOL,DROL                                                   R       59
C  *                                                                      R       60
C  ***    R ARRAY SEGMENT 10 - AFPO DATA.                                 R       61
C  *                                                                      R       62
      COMMON XU,XW,XQ,XFRPM,XCON,XPDIGV,XDE,ZU,ZW,ZC,ZFRPM,ZCON,ZPDIGV,   R       63
     A        ZDE,MU,MW,MWDOT,MQ,MFRPM,MCON,MPDIGV,MDE,                   R       64
     B         YV,YP,YR,YDA,YDR,LV,LP,LR,LDA,LDR,NV,NP,NR,                R       65
     C         NDA,NDR                                                    R       66
      REAL    MU,MW,MWDOT,MC,MFRPM,MCON,MPDICV,MDF                        R       67
      RFAL  LV,LP,LR,LDA,LDR,NV,NP,NR,NDA,NDR                             R       68
C  *                                                                      R       69
C  ***    R ARRAY SEGMENT 11                                              R       70
C  *                                                                      R       71
      COMMON  RC,RCD,XAPCOM,ERRX,ERRU,        ERRZ,ERRW, ETHETA,          R       72
     1         ERY,ERPHI,ERPSI,YCOM,PHICOM,PSICOM                         R       73
C  *                                                                      R       74
C  ***    R ARRAY SEGMENT 12 - CONTROLS.                                  R       75
C  *                                                                      R       76
      COMMON  DE,DT,DCON,DED,DTD,DCOND,                                   R       77
     1         DA,DR,DAP,DRP,DA1,DA2,DR1,DR2,DA1D,DA2D,DR1D,DR2D          R       78
C  *                                                                      R       79
C  ***    R ARRAY SEGMENT 13 - SPEED TABLE FOR AERO TABLE LOOKUPS.        R       80
C  *                                                                      R       81
      COMMON TABV1(6)                                                     R       82
C  *                                                                      R       83
C  ***    R ARRAY SEGMENT 14 -  TIME TABLE FOR OPEN LOOP COMMAND TABLE L  R       84
C  *                                                                      R       85
      COMMON TABV2(10)                                                    R       86
C  *                                                                      R       87
C  ***    R ARRAY SEGMENT 15 - UNUSED                                     R       88
C  *                                                                      R       89
C  *                                                                      R       90
C  ***    R ARRAY SEGMENT 16 - GDF RELATED STUFF                          R       91
C  *                                                                      R       92
      COMMON SIGDAP, SIGDRP, SIGDA, SIGDR, GAINDA, GAINDR                 R       93
C  *                                                                      R       94
C  ***    R ARRAY SEGMENT 17 - SHIP MOTION                                R       95
C  *                                                                      R       96
      COMMON KXS,ZETAXS,WNXS,KZS,ZETAZS,WNZS,KTS,ZETATS,WNTS,             R       97
     1          KYS,ZETAYS,WNYS,KRS,ZETARS,WNRS,KPS,ZETAPS,WNPS,TAUPRT    R       98
      REAL KXS,KZS,KTS,KYS,KRS,KPS                                        R       99
C  *                                                                      R      100
C  ***    R ARRAY SEGMENTS 20-23 - OPEN LOOP COMMAND TABLES.              R      101
C  *                                                                      R      102
      COMMON TABTC(10)                                                    R      103
      COMMON TRPMOL(10)                                                   R      104
      COMMON TCONOL(10)                                                   R      105
      COMMON TDEOL(10)                                                    R      106
C  *                                                                      R      107
C  ***    R ARRAY SEGMENTS 24-25    [illegible]                           R      108
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      C *                                                              R     109
         COMMON TAPR(10)                                               R     110
         COMMON TARRDCT(10)                                            R     111
      C *                                                              R     112
      C ***     R ARRAY SEGMENTS 27-48 - LONGITUDINAL AERO DATA TABLES  R     113
      C *                                                              R     114
         COMMON TXU(6)                                                 R     115
         COMMON TXW(6)                                                 R     116
         COMMON TXQ(6)                                                 R     117
         COMMON TXRPM(6)                                               R     118
         COMMON TXCON(6)                                               R     119
         COMMON TXPIGV(6)                                              R     120
         COMMON TXDE(6)                                                R     121
         COMMON TZU(6)                                                 R     122
         COMMON TZW(6)                                                 R     123
         COMMON TZQ(6)                                                 R     124
         COMMON TZRPM(6)                                               R     125
         COMMON TZCON(6)                                               R     126
         COMMON TZPIGV(6)                                              R     127
         COMMON TZDE(6)                                                R     128
         COMMON TMU(6)                                                 R     129
         COMMON TMW(6)                                                 R     130
         COMMON TMWD(6)                                                R     131
         COMMON TMQ(6)                                                 R     132
         COMMON TMRPM(6)                                               R     133
         COMMON TMCON(6)                                               R     134
         COMMON TMPIGV(6)                                              R     135
         COMMON TMDE(6)                                                R     136
      C *                                                              R     137
      C ***     R ARRAY SEGMENTS 50-54 - COVARIANCE MATRICIES (DO NOT OVERDIME R     138
      C *                                                              R     139
         COMMON  F(17,17),P(17,17),PDOT(17,17),GM(11,4),QM(4,4)        R     140
      C *                                                              R     141
      C ***     R ARRAY SEGMENTS 55-56 - STANDARD DEVIATIONS.          R     142
      C *                                                              R     143
         COMMON SIGMA(50)                                              R     144
         COMMON SIGMAXY(50)                                            R     145
      C *                                                              R     146
      C ***     R ARRAY SEGMENTS 57-62 - AIRWAKE TABLES                R     147
      C *                                                              R     148
         COMMON VXX(5,5,3)                                             R     149
         COMMON VYY(5,5,3)                                             R     150
         COMMON VZZ(5,5,3)                                             R     151
         COMMON SVXX(5,5,3)                                            R     152
         COMMON SVYY(5,5,3)                                            R     153
         COMMON SVZZ(5,5,3)                                            R     154
      C *                                                              R     155
      C ***     R ARRAY SEGMENTS 63-80 - OPTIMAL CONTROLLER GAINS      R     156
      C *                                                              R     157
         COMMON   TKDEU(6), TKDEW(6), TKDEQ(6), TKDET(6), TKDEX(6),    R     158
        1         TKDEZ(6), TKDEN(6), TKDEDE(6), TKDEDT(6),            R     159
        2         TKDTU(6), TKDTW(6), TKDTQ(6), TKDTT(6), TKDTX(6),    R     160
        3         TKDTZ(6), TKDTN(6), TKDTDE(6), TKDTDT(6)             R     161
      C *                                                              R     162
      C ***     R ARRAY SEGMENTS 81-106                                R     163
      C *                                                              R     164
         COMMON F1(6,6),G1(6,4),GAMMA(6,7),A(7,7),B(7,4),M1(1,1),M2(1,1), R  165
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            1     H(1,1),D(1,1),C(4,6),RL(4,4),W(1,1),VU(1,1),VY(1,1),                R        166
            2     VYI(1,1),S(1,1),FE(1,1),CE(1,1),PE(1,1),PED(1,1),                   R        167
            3     KG(1,1),FXHAT(1,1),PXHAT(1,1),PXHATD(1,1),PX(1,1),                  R        168
            4     CS(1,1)                                                             R        169
                REAL M1,M2,KG                                                         R        170
      C  *                                                                            R        171
      C  ***       R ARRAY SEGMENT 107 - MORE OPTIMAL CONTROLLER GAINS (NOISE REL R        172
      C  *                                                                            R        173
                COMMON  DEUR, DEWR, DEVX, DEVXD, DEVZ, DEVZD,                         R        174
            1           DTUR, DTWR, DTVX, DTVXD, DTVZ, DTVZD                          R        175
      C  *                                                                            R        176
      C  ***       R ARRAY SEGMENTS 108-119                                           R        177
      C  *                                                                            R        178
                COMMON  TDEUR(6), TDEWR(6), TDEVX(6), TDEVXD(6), TDEVZ(6),            R        179
            1           TDEVZD(6),  TDTUR(6), TDTWR(6), TDTVX(6), TDTVXD(6),          R        180
            2           TDTVZ(6), TDTVZD(6)                                           R        181
      C *                                                                             R        182
      C ***        R ARRAY SEGMENTS 120-134 - LAT/DIR AERO DATA TABLES                R        183
      C *                                                                             R        184
                COMMON  TYV(6), TYP(6), TYR(6), TYDA(6), TYDR(6),                     R        185
            1           TLV(6), TLP(6), TLR(6), TLDA(6), TLDR(6),                     R        186
            2           TNV(6), TNP(6), TNR(6), TNDA(6), TNDR(6)                      R        187
      C *                                                                             R        188
      C ***        R ARRAY SEGMENTS 135-139 - LONG. TERMS REQD FOR LAT/DIR CASE       R        189
      C *                                                                             R        190
                COMMON  TABUB(10),TABWB(10),TXAPP(10),TZAPP(10),TXSP(10)              R        191
      C  *                                                                            R        192
      C  ***       R ARRAY SEGMENTS 140-143 - TABLES OF NONLINEAR FUNCTIONS           R        193
      C  *                                                                            R        194
                COMMON TDAIN(4), TDAOUT(4), TDRIN(4),TDROUT(4)                        R        195
      C  ******************************************************************** C R        196
      C  *                                                                            I          2
      C  ***       I ARRAY SEGMENT 1 - INTEGER VARIABLES.                             I          3
      C  *                                                                            I          4
                COMMON/INTEGER/ICEES,NEQU,NSTATES,NPA,NOM,NGM,NPE,NPX,NOAW,NOINIT  I          5
      C  *                                                                            I          6
      C  ***       I ARRAY SEGMENT 4 - DERIVATIVE INDICES.                            I          7
      C  *                                                                            I          8
                COMMON/INTEGER/ INDX1(14)                                             I          9
      C  *                                                                            I         10
      C  ***       I ARRAY SEGMENT 5 - STATE INDICES.                                 I         11
      C  *                                                                            I         12
                COMMON/INTEGER/ INDX2(14)                                             I         13
      C  *                                                                            I         14
      C  ***       I ARRAY SEGMENT 6 - VARIOUS INDICES.                               I         15
      C  *                                                                            I         16
                COMMON/INTEGER/ INDXPD,INDXP,INDXPED,INDXPE,INDXPXD,INDXPX            I         17
      C   ******************************************************************* C I         18
      C  *                                                                            INTEG      2
      C  ***       TEMPORARY INTEGRATION STORAGE.                                     INTEG      3
      C  ***       DIMENSION = NEQU = NSTATES + NPA**2 + NPX**2 + NPE**2              INTEG      4
      C  *                                                                            INTEG      5
                COMMON/INTEG/ RI(2187),RT(2187)                                       INTEG      6
      C  *                                                                            PROP      12
      C  ***       MISCELLANEOUS CALCULATIONS                                         PROP      13
      C  *                                                                            PROP      14
                COSTO = COS(THETA0)                                                   PROP      15
            SINTO = SIN(THETAO)                                    PROP      16
            SINTA = SIN(THETAA)                                    PROP      17
            COSTA = COS(THETAA)                                    PROP      18
            SPHIA = SIN(PHIA)                                      PROP      19
            CPHIA = COS(PHIA)                                      PROP      20
            SPSIA = SIN(PSIA)                                      PROP      21
            CPSIA = COS(PSIA)                                      PROP      22
            TEMP1 = K1*TL1/TAUA                                    PROP      23
            TEMP2 = K2*TL2/TAUA                                    PROP      24
            TEMP3 = K1*KY*TL1/TAUA                                 PROP      25
            TEMP4 = 4.*K1*TL1/(TAUD*TAUA)                          PROP      26
            TEMP5 = B1 - TL1/TAUA                                  PROP      27
            TEMP6 = 4.*K2*TL2/(TAUD*TAUA)                          PROP      28
            TEMP7 = B2 - TL2/TAUA                                  PROP      29
            TEMP8 = SPHIA*SINTA*CPSIA - SPSIA*CPHIA                PROP      30
            TEMP9 = SPSIA*SINTA*SPHIA + CPHIA*CPSIA                PROP      31
            TEMPO = SPHIA*COSTA                                    PROP      32
      C *                                                          PROP      33
      C ***      F1 MATRIX                                         PROP      34
      C *                                                          PROP      35
            F1(1,1) = YV                                           PROP      36
            F1(1,2) = WO + YP                                      PROP      37
            F1(1,3) = YR - UO                                      PROP      38
            F1(1,4) = G*COSTO + YDA*TEMP1*GAINDA                   PROP      39
            F1(1,5) = YDR*TEMP2*GAINDR                             PROP      40
            F1(1,6) = YDA*TEMP3*GAINDA                             PROP      41
            F1(2,1) = LV                                           PROP      42
            F1(2,2) = LP                                           PROP      43
            F1(2,3) = LR                                           PROP      44
            F1(2,4) = LDA*TEMP1*GAINDA                             PROP      45
            F1(2,5) = LDR*TEMP2*GAINDR                             PROP      46
            F1(2,6) = LDA*TEMP3*GAINDA                             PROP      47
            F1(3,1) = NV                                           PROP      48
            F1(3,2) = NP                                           PROP      49
            F1(3,3) = NR                                           PROP      50
            F1(3,4) = NDA*TEMP1*GAINDA                             PROP      51
            F1(3,5) = NDR*TEMP2*GAINDR                             PROP      52
            F1(3,6) = NDA*TEMP3*GAINDA                             PROP      53
            F1(4,2) = 1.                                           PROP      54
            F1(4,3) = TAN(THETAO)                                  PROP      55
            F1(5,3) = 1./COSTO                                     PROP      56
            F1(6,1) = 1.                                           PROP      57
            F1(6,5) = UO*COSTC + WO*SINTO                          PROP      58
      C *                                                          PROP      59
      C ***      G1 MATRIX                                         PROP      60
      C *                                                          PROP      61
            G1(1,1) =  YDA * TEMP4 * GAINDA                        PROP      62
            G1(1,2) =  YDA * TEMP5 * GAINDA                        PROP      63
            G1(1,3) =  YDR * TEMP6 * GAINDR                        PROP      64
            G1(1,4) =  YDR * TEMP7 * GAINDR                        PROP      65
            G1(2,1) =  LDA * TEMP4 * GAINDA                        PROP      66
            G1(2,2) =  LDA * TEMP5 * GAINDA                        PROP      67
            G1(2,3) =  LDR * TEMP6 * GAINDR                        PROP      68
            G1(2,4) =  LDR * TEMP7 * GAINDR                        PROP      69
            G1(3,1) =  NDA * TEMP4 * GAINDA                        PROP      70
            G1(3,2) =  NDA * TEMP5 * GAINDA                        PROP      71
            G1(3,3) =  NDR * TEMP6 * GAINDR                        PROP      72
      G1(3,4) =  NDR * TEMP7 * GAINCR                              PROP      73
C *                                                                PROP      74
C ***      GAMMA MATRIX                                            PROP      75
C *                                                                PROP      76
      GAMMA(1,1) =  -YV                                            PROP      77
      GAMMA(1,2) =  -YV * TEMP8                                    PROP      78
      GAMMA(1,4).=  -YV * TEMP9                                    PROP      79
      GAMMA(1,6) =  -YV * TEMPO                                    PROP      80
      GAMMA(2,1) =  -LV                                            PROP      81
      GAMMA(2,2) =  -LV * TEMP8                                    PROP      82
      GAMMA(2,4) =  -LV * TEMP9                                    PROP      83
      GAMMA(2,6) =  -LV * TEMPO                                    PROP      84
      GAMMA(3,1) = -NV                                             PROP      85
      GAMMA(3,2) = -NV * TEMP8                                     PROP      86
      GAMMA(3,4) = -NV * TEMP9                                     PROP      87
      GAMMA(3,6) = -NV * TEMPO                                     PROP      88
C *                                                                PROP      89
C ***      A MATRIX                                                PROP      90
C *                                                                PROP      91
      A(1,1) =   -OMEGAV                                           PROP      92
      A(2,3) =   1.                                                PROP      93
      A(3,2) =   -WNSF*WNSF                                        PROP      94
      A(3,3) =   -0.8*WNSF                                         PROP      95
      A(4,5) =   1.                                                PROP      96
      A(5,4) =   -WNSF*WNSF                                        PROP      97
      A(5,5) =   -0.8*WNSF                                         PROP      98
      A(6,7) =   1.                                                PROP      99
      A(7,6) =   -WNSF*WNSF                                        PROP     100
      A(7,7) =   -0.8*WNSF                                         PROP     101
C *                                                                PROP     102
C ***      B MATRIX                                                PROP     103
C *                                                                PROP     104
      B(1,1) =  SQRT(KV)                                           PROP     105
      B(3,2) =  TR1*SIGMAVX                                        PROP     106
      B(5,3) =  TR1*SIGMAVY                                        PROP     107
      B(7,4) =  TR1*SIGMAVZ                                        PROP     108
C *                                                                PROP     109
C ***      C MATRIX                                                PROP     110
C *                                                                PROP     111
      C(1,4) = -1.                                                 PROP     112
      C(1,6) = -KY                                                 PROP     113
      C(2,4) =  K1/TAUA                                            PROP     114
      C(2,6) =  K1*KY/TAUA                                         PROP     115
      C(3,5) = -1.                                                 PROP     116
      C(4,5) =  K2/TAUA                                            PROP     117
C *                                                                PROP     118
C ***      RL MATRIX                                               PROP     119
C *                                                                PROP     120
      RL(1,1) =  -2./TAUD                                          PROP     121
      RL(2,1) =  4.*K1/(TAUD*TAUA)                                 PROP     122
      RL(2,2) =  -1./TAUA                                          PROP     123
      RL(3,3) =  -2./TAUD                                          PROP     124
      RL(4,3) =  4.*K2/(TAUD*TAUA)                                 PROP     125
      RL(4,4) =  -1./TAUA                                          PROP     126
C *                                                                PROP     127
C ***      F MATRIX                                                PROP     128
C *                                                                PROP     129
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      CALL LAYIN(F,1,1,NPA,F1,6,6,0)                                    PROP 130
      CALL LAYIN(F,1,7,NPA,GAMMA,6,7,0)                                 PROP 131
      CALL LAYIN(F,1,14,NPA,G1,6,4,0)                                   PROP 132
      CALL LAYIN(F,7,7,NPA,A,7,7,0)                                     PROP 133
      CALL LAYIN(F,14,1,NPA,C,4,6,0)                                    PROP 134
      CALL LAYIN(F,14,14,NPA,PL,4,4,0)                                  PROP 135
C *                                                                     PROP 136
C ***     GM MATRIX                                                     PROP 137
C *                                                                     PROP 138
      CALL LAYIN(GM,1,1,NGM,R,7,4,0)                                    PROP 139
C *                                                                     PROP 140
C ***     QM MATRIX                                                     PROP 141
C *                                                                     PROP 142
      QM(1,1)= 1.33333                                                  PROP 143
      QM(2,2)= 1.                                                       PROP 144
      QM(3,3)= 1.                                                       PROP 145
      QM(4,4)= 1.                                                       PROP 146
C                                                                       PROP 147
C  *****************          PROPAGATE COVARIANCE          ************ PROP 148
C                                                                       PROP 149
      CALL MULTABT(QM,NQM,NQM,GM,NGM,NQM,WK2)                           PROP 150
      CALL MULT(GM,NGM,NQM,WK2,NQM,NGM,G2)                              PROP 151
      IF(ICEFS.EQ.1.AND.NOINIT.EQ.0)                                    PROP 152
     *   CALL SOLVP(F,G2,NPA,NGM,P,PDOT,RI,FT)                          PROP 153
      CALL MULTNN(F,P,PDOT,NPA)                                         PROP 154
      CALL ADDTR(PDOT,NPA)                                              PROP 155
      CALL ADDNM(PDOT,G2,PDOT,NPA,NGM)                                  PROP 156
      RETURN                                                            PROP 157
      END                                                               PROP 158
      SUBROUTINE ROTATE(X,Y,ANG,IT,XR,YR)                                ROTATE     2
C*********************************************************************** ROTATE     3
C*                                                                     * ROTATE     4
C*      ROUTINE TO ROTATE AND TRANSFORM TO ANOTHER COORDINATE SYSTEM   * ROTATE     5
C*                                                                     * ROTATE     6
C*    INPUT ARGUMENTS                                                  * ROTATE     7
C*       X       - X COORDINATE                                        * ROTATE     8
C*       Y       - Y COORDINATE                                        * ROTATE     9
C*       ANG     - ANGLE OF ROTATION                                   * ROTATE    10
C*       IT      - SWITCH FOR CALCULATING TRANSFORMATION DELTAS        * ROTATE    11
C*                 IT - NEGATIVE:  NO TRANSFORMATION                   * ROTATE    12
C*                 IT - ZERO:      CALCULATE TRANSFORMATION DELTAS     * ROTATE    13
C*                 IT - POSITIVE:  USE PREVIOUS DELTAS                 * ROTATE    14
C*                                                                     * ROTATE    15
C*    OUTPUT ARGUMENTS                                                 * ROTATE    16
C*       XR      - X COORDINATE AFTER ROTATION AND TRANSFORMATION      * ROTATE    17
C*       YR      - Y COORDINATE AFTER ROTATION AND TRANSFORMATION      * ROTATE    18
C*                                                                     * ROTATE    19
C*********************************************************************** ROTATE    20
      RAD     = ANG*0.01745329                                           ROTATE    21
      SINANG  = SIN(RAD)                                                 ROTATE    22
      COSANG  = COS(RAD)                                                 ROTATE    23
      IF (IT .GT. 0) GO TO 50                                            ROTATE    24
      DX      = 0.0                                                      ROTATE    25
      DY      = 0.0                                                      ROTATE    26
      IF (IT .EQ. 0) DX = X - (X*COSANG - Y*SINANG)                      ROTATE    27
      IF (IT .EQ. 0) DY = Y - (X*SINANG + Y*COSANG)                      ROTATE    28
   50 CONTINUE                                                           ROTATE    29
      XR      = X*COSANG - Y*SINANG + DX                                 ROTATE    30
      YR      = X*SINANG + Y*COSANG + DY                                 ROTATE    31
      RETURN                                                             ROTATE    32
      END                                                                ROTATE    33
      SUPPOUTINE RUNGE                                                  RUNGE      2
C ********************************************************************** RUNGE      3
C ***                                                                   RUNGE      4
C ***    ROUTINE TO PERFORM FOURTH OPDER RUNGF-KUTTA INTEGRATION.       RUNGF      5
C ***                                                                   RUNGE      6
C ********************************************************************** PUNGE      7
C *                                                                     R2         2
C ***    REAL VARIABLES (PROBLEM DEPENCENT).                            R2         3
C *                                                                     P2         4
      COMMON R(6)                                                       R2         5
C *                                                                     R2         6
C ***    INTEGRATION VARIABLES (LOCATIONS ARE PROBLEM DEPENDENT).       R2         7
C *                                                                     R2         8
      EQUIVALENCE (TI,R(1)),(TO,R(2)),(DT,R(3)),(DTOUT,R(4)),           R2         9
     A            (DTOUT2,R(5)),(TMAX,R(6))                             R2        10
C *                                                                     I          2
C ***    I ARRAY SEGMENT 1 - INTEGER VARIABLES.                         I          3
C *                                                                     I          4
      COMMON/INTEGER/ICEES,NEQU,NSTATES,NPA,NQM,NGM,NPE,NPX,NOAW,NGINIT I          5
C *                                                                     I          6
C ***    I APRAY SEGMENT 4 - DERIVATIVE INDICES.                        I          7
C *                                                                     I          8
      COMMON/INTEGEP/ INDX1(14)                                         I          9
C *                                                                     I         10
C ***    I ARRAY SEGMENT 5 - STATE INDICES.                             I         11
C *                                                                     I         12
      COMMON/INTEGEP/ INDX2(14)                                         I         13
C *                                                                     I         14
C ***    I ARRAY SEGMENT 6 - VAPIOUS INDICES.                           I         15
C *                                                                     I         16
      COMMON/INTEGER/ INDXPD,INDXP,INDXPED,INDXPE,INDXPXD,INDXPX        I         17
C  ***************************************************************    C I         18
C *                                                                     INTEG      2
C ***    TEMPORARY INTEGRATION STORAGE.                                 INTEG      3
C ***    DIMENSION = NEQU = NSTATES + NPA**2 + NPX**2 + NPE**2          INTEG      4
C *                                                                     INTEG      5
      COMMON/INTEG/ RI(2187),RT(2167)                                   INTEG      6
C *                                                                     RUNGE     11
C ***    COMPLETE FIRST STAGE AT THIS INTEGRATION STEP.                 RUNGE     12
C *                                                                     RUNGE     13
      TEMP1        = 0.1666666667*DT                                    RUNGE     14
C ***    STATES.                                                        RUNGE     15
      DO 10 I=1,NSTATES                                                 RUNGE     16
      RI(I)        = R(INDX2(I))                                        RUNGE     17
      RT(I)        = RI(I) + TEMP1*R(INDX1(I))                          PUNGE     18
   10 CONTINUE                                                          RUNGE     19
C ***    P.                                                             RUNGE     20
      NL1 =  NSTATES + 1                                                RUNGE     21
      NU1 =  NSTATES + NPA + NPA                                        RUNGE     22
      I1           = INDXPD                                             RUNGE     23
      I2           = INDXP                                              RUNGE     24
      DO 20 I=NL1,NU1                                                   RUNGE     25
      RI(I)        = R(I2)                                              RUNGE     26
      RT(I)        = RI(I) + TEMP1*R(I1)                                RUNGE     27
      I1           = I1 + 1                                             RUNGE     28
      I2           = I2 + 1                                             RUNGE     29
   20 CONTINUE                                                          RUNGE     30
```

```
      C  ***   PE.                                                             RUNGE     31
         NL2            = NU1 + 1                                              RUNGF     32
         NU2            = NU1 + NPE * NPE                                      RUNGE     33
         I1             = INDXPED                                              RUNGE     34
         I2             = INDXPE                                               RUNGE     35
         DO 21 I=NL2,NU2                                                       RUNGE     36
         RI(I)          = R(I2)                                                RUNGE     37
         RT(I)          = RI(I) + TEMP1*R(I1)                                  RUNGE     38
         I1             = I1 + 1                                               RUNGE     39
         I2             = I2 + 1                                               RUNGE     40
   21    CONTINUF                                                              RUNGE     41
      C  ***   PX.                                                             RUNGE     42
         NL3            = NU2 + 1                                              RUNGE     43
         NEQU           = NU2 + NPX * NPX                                      RUNGE     44
         I1             = INDXPXD                                              RUNGE     45
         I2             = INDXPX                                               RUNGE     46
         DC 22 I=NL3,NEQU                                                      RUNGE     47
         RI(I)          = R(I2)                                                RUNGE     48
         RT(I)          = RI(I) + TEMP1*R(I1)                                  RUNGF     49
         I1             = I1 + 1                                               RUNGE     50
         I2             = I2 + 1                                               RUNGE     51
   22    CONTINUE                                                              RUNGE     52
      C  *                                                                     RUNGF     53
      C  ***   COMPLETE INTEGRATION AT THIS INTEGRATION STEP.                  RUNGE     54
      C  *                                                                     RUNGE     55
         TEMP1          = DT/3.0                                               RUNGE     56
         TEMP2          = 0.5*DT                                               RUNGE     57
         DO 70 IC=1,3                                                          RUNGE     58
         TI             = TO + TEMP2                                           RUNGF     59
      C  ***   STATES.                                                         RUNGE     60
         DO 30 I=1,NSTATES                                                     RUNGE     61
         R(INDX2(I)) = RI(I) + TEMP2*R(INDX1(I))                               RUNGE     62
   30    CONTINUE                                                              RUNGF     63
      C  ***   P.                                                              RUNGE     64
         I1             = INDXPD                                               RUNGE     65
         I2             = INDXP                                                RUNGE     66
         DO 40 I=NL1,NU1                                                       RUNGE     67
         R(I2)          = RI(I) + TEMP2*R(I1)                                  RUNGE     68
         I1             = I1 + 1                                               RUNGE     69
         I2             = I2 + 1                                               RUNGE     70
   40    CONTINUE                                                              RUNGE     71
      C  ***   PE.                                                             RUNGE     72
         I1             = INDXPED                                              RUNGE     73
         I2             = INDXPE                                               RUNGE     74
         DO 41 I=NL2,NU2                                                       RUNGE     75
         R(I2)          = RI(I) + TEMP2*R(I1)                                  RUNGE     76
         I1             = I1 + 1                                               RUNGE     77
         I2             = I2 + 1                                               RUNGE     78
   41    CONTINUE                                                              RUNGE     79
      C  ***   PX.                                                             RUNGF     80
         I1             = INDXPXD                                              RUNGE     81
         I2             = INDXPX                                               RUNGE     82
         DC 42 I=NL3,NEQU                                                      RUNGE     83
         R(I2)          = RI(I) + TEMP2*R(I1)                                  RUNGE     84
         I1             = I1 + 1                                               RUNGF     85
         I2             = I2 + 1                                               RUNGE     86
   42    CONTINUE                                                              RUNGE     87
```

```
            CALL DEQU
            CALL PROP
      C ***    STATES.
            DO 50 I=1,NSTATES
            RT(I)          = RT(I) + TEMP1*R(INDX1(I))
      50    CONTINUE
      C ***    P.
            I1             = INDXPO
            DO 60 I=NL1,NU1
            RT(I)          = RT(I) + TEMP1*R(I1)
            I1             = I1 + 1
      60    CONTINUE
      C ***    PE.
            I1             = INDXPED
            DO 61 I=NL2,NU2
            RT(I)          = RT(I) + TEMP1*R(I1)
            I1             = I1 + 1
      61    CONTINUE
      C ***    PX.
            I1             = INDXPXD
            DO 62 I=NL3,NEQU
            RT(I)          = RT(I) + TEMP1*R(I1)
            I1             = I1 + 1
      62    CONTINUE
            IF(IC.NE.2) GO TO 70
            TEMP1          = DT/6.0
            TEMP2          = DT
      70    CONTINUE
      C ***    STATES.
            DO 80 I=1,NSTATES
            R(INDX2(I)) = RT(I)
      80    CONTINUE
      C ***    P.
            I2             = INDXP
            DO 90 I=NL1,NU1
            R(I2)          = RT(I)
            I2             = I2 + 1
      90    CONTINUE
      C ***    PE.
            I2             = INDXPE
            DO 91 I=NL2,NU2
            R(I2)          = RT(I)
            I2             = I2 + 1
      91    CONTINUE
      C ***    PX.
            I2             = INDXPX
            DO 92 I=NL3,NEQU
            R(I2)          = RT(I)
            I2             = I2 + 1
      92    CONTINUE
      C *
      C ***    GENERATE DERIVATIVES AND STATES FOR NEXT INTEGRATION STEP.
      C *
            TO             = TO + DT
            ICFES          = 0
            CALL DEQU
            CALL PROP
```

```
                 ICFFS     = 2                                                                    RUNGF       145
                 RETURN                                                                           RUNGE       146
                 FED                                                                              RUNGE       147
```

```
      SUBROUTINE SETUP(INT)                                            SETUP      2
C*********************************************************************** SETUP      3
C*                                                                    * SETUP      4
C*      ROUTINE TO INITIALIZE THE INTEGRATORS AND PERFORM ONE TIME     * SETUP      5
C*      ONLY CALCULATIONS.                                             * SETUP      6
C*                                                                    * SETUP      7
C*   INPUT ARGUMENTS                                                  * SETUP      8
C*      INT       INTEGRATION OPTION.                                  * SETUP      9
C*                1 = 4 TH ORDER RUNGE-KUTTA.                          * SETUP     10
C*                2 = 3 RD ORDER RUNGE-KUTTA.                          * SETUP     11
C*                3 = 2 ND ORDER ADAMS.                                * SETUP     12
C*                                                                    * SETUP     13
C*********************************************************************** SETUP     14
      DIMENSION R(1)                                                   SETUP     15
C  *                                                                   R          2
C  ***    R ARRAY SEGMENT 1 - INTEGRATION VARIABLES.                   R          3
C  *                                                                   R          4
      COMMON TIME,TO,DTIME,DTOUT,DTOUT2,TMAX                           R          5
C  *                                                                   R          6
C  ***    R ARRAY SEGMENT 2 - DERIVATIVES.                             R          7
C  *                                                                   R          8
      COMMON UDOT,WDOT,QDOT,TDOT,XAPPDOT,ZAPPDOT,DFRPMD,XSPDOT,        R          9
     A       ZSPDOT,TSPDOT,                                           R         10
     B       VDOT,PBDOT,RBDOT,YAPPDOT,PHIDOT,PSIDOT,YSPDOT            R         11
C  *                                                                   R         12
C  ***    R ARRAY SEGMENT 3 - STATE VARIABLES.                         R         13
C  *                                                                   R         14
      COMMON UB,WB,QB,THETA,XAPP,ZAPP,DFRPM,XSP,ZSP,THETAS,            R         15
     A        VB,PB,RB,YAPP,PHI,PSI,YSP                                R         16
C  *                                                                   R         17
C  ***    R ARRAY SEGMENT 4 - REF. VALUES FOR LOCAL LINEARIZATION.     R         18
C  *                                                                   R         19
      COMMON UO,WO,QO,THETAO,XAPPO,ZAPPO,XO,ZO,MO,UBASO,WBASO,WASDO,   R         20
     A       THETAAO,PSIAO,PHIAO,RCDO,VO,PO,RO,YAPPO,PHIO,PSIO,YO,LO,  R         21
     B       NO,VBASO                                                 R         22
      REAL   MO,LO,NO                                                  R         23
C  *                                                                   R         24
C  ***    R ARRAY SEGMENT 5 - INPUT FORCES AND MOMENTS.                R         25
C  *                                                                   R         26
      COMMON SUMFXO,SUMFZO,SUMMO,SUMFX,DFX,SUMFZ,DFZ,SUMM,DM,          R         27
     A       SUMFYO,SUMLO,SUMNO,SUMFY,DFY,SUML,DL,SUMN,DN              R         28
C  *                                                                   R         29
C  ***    R ARRAY SEGMENT 6 - GEOMETRY.                                R         30
C  *                                                                   R         31
      COMMON WEIGHT,G,IX,IY,IZ,IXZ,LM,WM,LTOM,LS,LTOS                  R         32
      REAL   G,IX,IY,IZ,IXZ,LM,LTOM,LS,LTOS                            R         33
C  *                                                                   R         34
C  ***    R ARRAY SEGMENT 7 - CONSTANTS.                               R         35
C  *                                                                   R         36
      COMMON  OMEGAU,OMEGAW,KU,KW,KFRPM,KCON,TAUENG,TAUCON,TAUD,       R         37
     1         KDEU,KDEW,KDEC,KDET,KDEX,KDEZ,KDEN,KDEDE,KDEDT,         R         38
     2         KDTU,KDTW,KDTO,KDTT,KDTX,KDTZ,KDTN,KDTDE,KDTDT,         R         39
     3        OMEGAV,KV,TAUA,K1,K2,KY,B1,B2,TL1,TL2                    R         40
      REAL  KU,KW,KFRPM,KCON,                                          R         41
     1       KDEU,KDEW,KDEO,KDET,KDEX,KDEZ,KDEN,KDEDF,KDEDT,           R         42
     2       KDTU,KDTW,KDTO,KDTT,KDTX,KDTZ,KDTN,KDTDE,KDTDT,           R         43
     3        K1,K2,KY,KV                                              R         44
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      C  *                                                                     R         45
      C  ***     P ARRAY SEGMENT 8 - WIND, ALTITUDE, AIRSPEED AND AIRWAKE.     R         46
      C  *                                                                     R         47
          COMMON ALT,VAIR,UBAS,VBAS,WBAS,ALPHA,EFTA,DUM1,DUM2,V5,PSI5,X1DWS,   R         48
         A       Y1DWS,VAPB,PSIAME,X1DWA,Y1DWA,Z1DWA,VWOD,PSIWOD,PSI3,PSISP,   R         49
         B       PSIS,DX45,DY45,DZ45,XM,YM,ZM,PSIA,THETAA,PHIA,SIGMAVX,        R         50
         C       SIGMAVY,SIGMAVZ,VXAW,VYAW,VZAW,UWIND,UMEAN,UR,UAW,VWIND,      R         51
         D       VMEAN,VR,VAW,WWIND,WMEAN,WR,WAW,WNSF,PSISS,PSISC,PSIST,TS1,   R         52
         E       TS2,TS3,TS4,TS5,TR1,DXP145,DXP245,DYM145,DYM245,ZGSP,         R         53
         F       ZBIASP                                                        R         54
      C  *                                                                     R         55
      C  ***     R ARRAY SEGMENT 9 - OPEN LOOP PARAMETERS.                     R         56
      C  *                                                                     R         57
          COMMON THETAC,DFRPMOL,DCDNOL,DEOL,GAMMAGS,RANGE,VAIRC,               R         58
         1       DAOL,DROL                                                     R         59
      C  *                                                                     R         60
      C  ***     R ARPAY SEGMENT 10 - AERO DATA.                               R         61
      C  *                                                                     R         62
          COMMON XU,XW,XO,XFRPM,XCDN,XPDIGV,XDE,ZU,ZW,ZG,ZFRPM,ZCDN,ZPDIGV,    R         63
         A       ZDE,MU,MW,MWDOT,MQ,MF&PM,MCON,MPDIGV,MDE,                     R         64
         B        YV,YP,YR,YDA,YDR,LV,LP,LR,LDA,LDR,NV,NP,NR,                  R         65
         C        NDA,NDR                                                      R         66
          REAL   MU,MW,MWDOT,MQ,MFRPM,MCON,MPDIGV,MDE                          R         67
          REAL  LV,LP,LR,LDA,LDR,NV,NP,NR,NDA,NDR                              R         68
      C  *                                                                     R         69
      C  ***     R ARRAY SEGMENT 11                                            R         70
      C  *                                                                     R         71
          COMMON  RC,RCD,XAPCOM,ERRX,ERRU,       ERRZ,ERRW, ETHETA,            R         72
         1        ERY,ERPHI,ERPSI,YCOM,PHICOM,PSICOM                           R         73
      C  *                                                                     R         74
      C  ***     R ARRAY SEGMENT 12 - CONTROLS.                                R         75
      C  *                                                                     R         76
          COMMON  DE,DT,DCDN,DED,DTD,DCDND,                                    R         77
         1        DA,DR,DAP,DRP,DA1,DA2,DR1,DR2,DA1D,DA2D,DR1D,DR2D            R         78
      C  *                                                                     R         79
      C  ***     R ARRAY SEGMENT 13 - SPEED TABLE FOR AERO TABLE LOOKUPS.      R         80
      C  *                                                                     R         81
          COMMON TABV1(6)                                                      R         82
      C  *                                                                     R         83
      C  ***     R ARRAY SEGMENT 14 -  TIME TABLF FOR OPEN LOOP COMMAND TABLE L R         84
      C  *                                                                     R         85
          COMMON TABV2(10)                                                     R         86
      C  *                                                                     R         87
      C  ***     R ARRAY SEGMENT 15 - UNUSED                                   R         88
      C  *                                                                     R         89
      C  *                                                                     R         90
      C  ***     R ARRAY SEGMENT 16 - GDF RELATED STUFF                        R         91
      C  *                                                                     R         92
          COMMON SIGDAP, SIGDRP, SIGDA, SIGDR, GAINDA, GAINDR                  R         93
      C  *                                                                     R         94
      C  ***     R ARRAY SEGMENT 17 - SHIP MOTION                              R         95
      C  *                                                                     R         96
          COMMON KXS,ZETAXS,WNXS,KZS,ZETAZS,WNZS,KTS,ZETATS,WNTS,              R         97
         1        KYS,ZETAYS,WNYS,KRS,ZETARS,WNRS,KPS,ZETAPS,WNPS,TAUPRT       R         98
          REAL KXS,KZS,KTS,KYS,KRS,KPS                                         R         99
      C  *                                                                     R        100
      C  ***     R ARRAY SEGMENTS 20-23 - OPEN LOOP COMMAND TABLES.             R        101
      C  *                                                             R      102
         COMMON TARTC(10)                                              R      103
         COMMON TREFCL(10)                                             R      104
         COMMON TCONCL(10)                                             P      105
         COMMON TDEOL(10)                                              R      106
      C  *                                                             R      107
      C  ***    R ARRAY SEGMENTS 24-25                                 R      108
      C  *                                                             R      109
         COMMON TABR(10)                                               R      110
         COMMON TABROCT(10)                                            R      111
      C  *                                                             R      112
      C  ***    R ARRAY SEGMENTS 27-48 - LONGITUDINAL AERO DATA TABLES R      113
      C  *                                                             R      114
         COMMON TXU(6)                                                 R      115
         COMMON TXW(6)                                                 R      116
         COMMON TXQ(6)                                                 R      117
         COMMON TXRPM(6)                                               R      118
         COMMON TXCON(6)                                               R      119
         COMMON TXPIGV(6)                                              R      120
         COMMON TXDE(6)                                                R      121
         COMMON TZU(6)                                                 R      122
         COMMON TZW(6)                                                 R      123
         COMMON TZQ(6)                                                 R      124
         COMMON TZRPM(6)                                               R      125
         COMMON TZCON(6)                                               R      126
         COMMON TZPIGV(6)                                              R      127
         COMMON TZDE(6)                                                R      128
         COMMON TMU(6)                                                 R      129
         COMMON TMW(6)                                                 R      130
         COMMON TMWD(6)                                                R      131
         COMMON TMQ(6)                                                 R      132
         COMMON TMRPM(6)                                               R      133
         COMMON TMCON(6)                                               R      134
         COMMON TMPIGV(6)                                              R      135
         COMMON TMDE(6)                                                R      136
      C  *                                                             R      137
      C  ***    R ARRAY SEGMENTS 50-54 - COVARIANCE MATRICIES (DO NOT OVERDIME R  138
      C  *                                                             R      139
         COMMON  F(17,17),P(17,17),PDOT(17,17),GM(11,4),QM(4,4)        R      140
      C  *                                                             R      141
      C  ***    R ARRAY SEGMENTS 55-56 - STANDARD DEVIATIONS.          R      142
      C  *                                                             R      143
         COMMON SIGMA(50)                                              R      144
         COMMON SIGMAXY(50)                                            R      145
      C  *                                                             P      146
      C  ***    P ARRAY SEGMENTS 57-62 - AIRWAKE TABLES                R      147
      C  *                                                             R      148
         COMMON VXX(5,5,3)                                             R      149
         COMMON VYY(5,5,3)                                             R      150
         COMMON VZZ(5,5,3)                                             R      151
         COMMON SVXX(5,5,3)                                            R      152
         COMMON SVYY(5,5,3)                                            R      153
         COMMON SVZZ(5,5,3)                                            R      154
      C  *                                                             R      155
      C  ***    R ARRAY SEGMENTS 63-80 - OPTIMAL CONTROLLER GAINS       R      156
      C  *                                                             R      157
         COMMON  TKDEU(6), TKDEW(6), TKDEQ(6), TKDET(6), TKDEX(6),     R      158
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                 1     TKDEZ(6), TKDEN(6), TKDEDF(6), TKDEDT(6),                        R        159
                 2     TKDTU(6), TKDTW(6), TKDTO(6), TKDTT(6), TKDTX(6),                R        160
                 3     TKDTZ(6), TKDTN(6), TKDTDE(6), TKDTDT(6)                         R        161
           C  *                                                                         R        162
           C  ***     R ARRAY SEGMENTS 81-106                                           R        163
           C  *                                                                         R        164
                COMMON F1(6,6),G1(6,4),GAMMA(6,7),A(7,7),B(7,4),M1(1,1),M2(1,1),        R        165
                 1     H(1,1),D(1,1),C(4,6),RL(4,4),W(1,1),VU(1,1),VY(1,1),             R        166
                 2     VYI(1,1),S(1,1),FE(1,1),QE(1,1),PE(1,1),PED(1,1),                R        167
                 3     KG(1,1),FXHAT(1,1),PXHAT(1,1),PXHATD(1,1),PX(1,1),               R        168
                 4     CS(1,1)                                                          R        169
                REAL M1,M2,KG                                                           R        170
           C  *                                                                         R        171
           C  ***     R ARRAY SEGMENT 107 - MCRE OPTIMAL CONTROLLER GAINS (NOISE REL    R        172
           C  *                                                                         R        173
                COMMON  DEUR, DEWR, DEVX, DEVXD, DEVZ, DEVZD,                           R        174
                 1      DTUR, DTWR, DTVX, DTVXD, DTVZ, DTVZD                            R        175
           C  *                                                                         R        176
           C  ***     R ARRAY SEGMENTS 108-119                                          R        177
           C  *                                                                         R        178
                COMMON  TDEUR(6), TDEWR(6), TDEVX(6), TDEVXD(6), TDEVZ(6),              R        179
                 1      TDEVZD(6),  TDTUR(6), TDTWR(6), TDTVX(6), TDTVXD(6),            R        180
                 2      TDTVZ(6), TDTVZD(6)                                             R        181
           C  *                                                                         R        182
           C  ***     R ARRAY SEGMENTS 120-134 - LAT/DIR AERO DATA TABLES               R        183
           C  *                                                                         R        184
                COMMON  TYV(6), TYP(6), TYR(6), TYDA(6), TYDR(6),                       R        185
                 1      TLV(6), TLP(6), TLR(6), TLDA(6), TLDR(6),                       R        186
                 2      TNV(6), TNP(6), TNR(6), TNDA(6), TNDR(6)                        R        187
           C  *                                                                         R        188
           C  ***     R ARRAY SEGMENTS 135-139 - LONG. TERMS REQD FOR LAT/DIR CASE      R        189
           C  *                                                                         R        190
                COMMON  TABUB(10),TABWB(10),TXAPP(10),TZAPP(1C),TXSP(10)                R        191
           C  *                                                                         R        192
           C  ***     R ARRAY SEGMENTS 140-143 - TABLES OF NONLINEAR FUNCTIONS          R        193
           C  *                                                                         R        194
                COMMON TDAIN(4), TDAOUT(4), TDRIN(4),TDROUT(4)                          R        195
           C  ****************************************************************** C R        196
           C  *                                                                         I          2
           C  ***     I ARRAY SEGMENT 1 - INTEGER VARIABLES.                            I          3
           C  *                                                                         I          4
                COMMON/INTEGER/ICEES,NEQU,NSTATES,NPA,NQM,NGM,NPE,NPX,NDAW,NOINIT       I          5
           C  *                                                                         I          6
           C  ***     I ARRAY SEGMENT 4 - DERIVATIVE INDICES.                           I          7
           C  *                                                                         I          8
                COMMON/INTEGER/ INDX1(14)                                               I          9
           C  *                                                                         I         10
           C  ***     I ARRAY SEGMENT 5 - STATE INDICES.                                I         11
           C  *                                                                         I         12
                COMMON/INTEGER/ INDX2(14)                                               I         13
           C  *                                                                         I         14
           C  ***     I ARRAY SEGMENT 6 - VARIOUS INDICES.                              I         15
           C  *                                                                         I         16
                COMMON/INTEGER/ INDXPD,INDXP,INDXPED,INDXPE,INDXPXD,INDXPX              I         17
           C  ****************************************************************** C I          18
           C  *                                                                       INTEG        2
           C  ***     TEMPORARY INTEGRATION STORAGE.                                  INTEG        3
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      C  ***    DIMENSION = NEQU = NSTATES + NPA**2 + NPX**2 + NPE**2       INTEG       4
      C  *                                                                  INTEG       5
             COMMON/INTEG/ RI(2187),PT(2187)                                INTEG       6
      C  *                                                                  SETUP      19
      C  ***    R ARRAY EQUIVALENCE STATEMENT (PROBLEM DEPENDENT).           SETUP      20
      C  *                                                                  SETUP      21
             EQUIVALENCE (R(1),TIME)                                        SETUP      22
      C                                                                   C SETUP      23
      C**************           WIND CALCULATIONS             **************C SETUP      24
      C                                                                   C SETUP      25
      C  *                                                                  SETUP      26
      C  ***    EARTH AXIS COMPONENTS OF AMBIENT WIND.                      SETUP      27
      C  *                                                                  SETUP      28
             X1DWA    = VAMB*COS(PSIAMB)                                    SETUP      29
             Y1DWA    = VAMB*SIN(PSIAMB)                                    SETUP      30
      C  *                                                                  SETUP      31
      C  ***    EARTH AXIS COMPONENTS OF SHIP RELATIVE WIND.                SETUP      32
      C  *                                                                  SETUP      33
             X1DWS    = V5*COS(PSI5 - 3.14159)                              SETUP      34
             Y1DWS    = V5*SIN(PSI5 - 3.14159)                              SETUP      35
      C  *                                                                  SETUP      36
      C  ***    WIND OVER DECK.                                             SETUP      37
      C  *                                                                  SETUP      38
             VWOD     = SQRT((X1DWA + X1DWS)**2 + (Y1DWA + Y1DWS)**2)       SETUP      39
             PSIWOD   = 0.0                                                 SETUP      40
             XDUM     = X1DWA + X1DWS + Y1DWA + Y1DWS                       SETUP      41
             IF(XDUM.NE.0.0) PSIWOD = ATAN2(Y1DWA+Y1DWS,X1DWA+X1DWS)        SETUP      42
      C  *                                                                  SETUP      43
      C  ***    ORIENTATION OF SHIP WIND AXIS SYSTEM.                       SETUP      44
      C  *                                                                  SETUP      45
             PSI3     = PSIWOD - 3.14159                                    SETUP      46
      C  ***     TRANSFORMATION ANGLES.                                     SETUP      47
             PSISP    = PSI3 - PSI5                                         SETUP      48
             TWOPI = 2.0*3.14159                                            SETUP      49
             IF(PSISP .LT. -TWOPI) PSISP = PSISP + TWOPI                    SETUP      50
             IF(PSISP .GT. TWOPI) PSISP = PSISP - TWOPI                     SETUP      51
             PSIS     =-PSISP                                               SETUP      52
             TS1      = COS(PSISP)                                          SETUP      53
             TS2      = SIN(PSISP)                                          SETUP      54
             TS3      = COS(PSI5)                                           SETUP      55
             TS4      = SIN(PSI5)                                           SETUP      56
             DXM145   = TS1*TS3 - TS2*TS4                                   SETUP      57
             DXM245   = TS1*TS4 + TS2*TS3                                   SETUP      58
             DYM145   =-TS2*TS3 - TS1*TS4                                   SETUP      59
             DYM245   = TS1*TS3 - TS2*TS4                                   SETUP      60
             AWFLG = 0.0                                                    SETUP      61
             IF(VWOD.LT.32.0.OR.VWOD.GT.78.0) AWFLG = 1.0                   SETUP      62
             IF(PSIS.LT.0.50611.OR.PSIS.GT.0.89005) AWFLG = 1.0             SETUP      63
             IF(NOAW.EQ.1) GO TO 10                                         SETUP      64
             VEL = VWOD/1.688                                               SETUP      65
             ANG = PSIS*57.3                                                SETUP      66
             IF(AWFLG.NE.0.0) WRITE(6,1000) VEL,ANG                         SETUP      67
        1000 FORMAT(1H1,*****  WARNING  ****  WARNING  ****  WARNING *****# //  SETUP      68
            *       4X,#THE NO AIRWAKE FLAG (NOAW) HAS BEEN SET.# /         SETUP      69
            *       1X,#VWOD OF #,F4.1,# KNOTS OR PSIS OF #,F4.1,# DEGREES# SETUP      70
            *         #IS NOT IN THE AIRWAKE TABLE.# /                      SETUP      71
            *       1X,#THEREFORE. THIS RUN DOES NOT HAVE AIRWAKE DATA.# // SETUP      72
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     *          1X,***** WARNING  ****  WARNING  ****  WARNING  *****)       SETUP      73
      IF(AWFLG.NE.0.0) NDAW = 1                                              SETUP      74
      IF(AWFLG.NE.0.0) GO TO 10                                              SETUP      75
C                                                                          C SETUP      76
C**************  AIRWAKE MODEL PRELIMINARY CALCULATIONS   **************C SETUP      77
C                                                                          C SETUP      78
C  *                                                                         SETUP      79
C  ***    GENERATE AIRWAKE TABLES BASED ON VWOD AND PSIS.                    SETUP      80
C  *                                                                         SETUP      81
      CALL AIRWTBL                                                           SETUP      82
C  *                                                                         SETUP      83
C  ***    SCALING RELATIONS.                                                 SETUP      84
C  *                                                                         SETUP      85
      XDUM     = 46.75/WM                                                    SETUP      86
      LS       = LM*XDUM                                                     SETUP      87
      LTDS     = LTDM*XDUM                                                   SETUP      88
      WNSF     = 1.9*XDUM*VWOD/59.15                                         SETUP      89
C  *                                                                         SETUP      90
C  ***    SHAPING TERMS.                                                     SETUP      91
C  *                                                                         SETUP      92
      PSISS    = SIN(PSIS)                                                   SETUP      93
      PSISC    = COS(PSIS)                                                   SETUP      94
      PSIST    = PSISS/PSISC                                                 SETUP      95
      TS1      = PSISS*LTDS - PSISS*LS - 23.375*PSISC                        SETUP      96
      TS2      = PSISS*LTDS + 23.375*PSISC                                   SETUP      97
      TS3      = PSISC*LTDS - PSISC*LS + 23.375*PSISS                        SETUP      98
      TS4      = 23.375/PSISS                                                SETUP      99
      TS5      = 23.375/PSISC                                                SETUP     100
C  *                                                                         SETUP     101
C  ***    RANDOM COMPONENT TERM.                                             SETUP     102
C  *                                                                         SETUP     103
      TR1      = SQRT(1.6*WNSF*WNSF*WNSF)                                    SETUP     104
C                                                                            SETUP     105
C**************          GDF INITIALIZATION               **************C SETUP     106
C                                                                            SETUP     107
C  *                                                                         SETUP     108
C  ***    TABRD SETS UP TABLES FOR DESCRIRING FUNCTION SUBROUTINE            SETUP     109
C  *                                                                         SETUP     110
C     ROLL CONTROL NONLINEARITY                                              SETUP     111
      CALL TABRD(TDAIN,TDAOUT,4)                                             SETUP     112
C     YAW CONTROL NONLINEARITY                                               SETUP     113
      CALL TABRD(TDRIN,TDROUT,4)                                             SETUP     114
C                                                                          C SETUP     115
C**************              SET UP INTEGRATION           **************C SETUP     116
C                                                                          C SETUP     117
10    ICEES    = 1                                                           SETUP     118
      TIME     = TO                                                          SETUP     119
      XMASS    = WEIGHT/G                                                    SETUP     120
      YC       = SUMFYO/XMASS                                                SETUP     121
      LO       = (IZ*SUMLO+IXZ*SUMNO)/(IX*IZ-IXZ*IXZ)                        SETUP     122
      NO       = (IX*SUMNO+IXZ*SUMLO)/(IX*IZ-IXZ*IXZ)                        SETUP     123
      UBASO    = UBAS                                                        SETUP     124
      VBASO    = VBAS                                                        SETUP     125
      WBASO    = WBAS                                                        SETUP     126
      PO =  PB                                                               SETUP     127
      RO =  RB                                                               SETUP     128
      CALL DEQU                                                              SETUP     129
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              XDUM      = WNSI*WNSF                                 SETUP     130
              P(7,7)    = 1.C                                       SETUP     131
              P(8,8)= SIGMAVX*SIGMAVX                               SFTUP     132
              P(9,9)= XDUP*P(8,8)                                   SETUP     133
              P(10,10)= SIGMAVY*SIGMAVY                             SETUP     134
              P(11,11)= XDUM*P(10,10)                               SETUP     135
              P(12,12)= SIGMAVZ*SIGMAVZ                             SETUP     136
              P(13,13)= XDUM*P(12,12)                               SETUP     137
              CALL PROP                                             SETUP     138
              ICEES     = 2                                         SETUP     139
              IF(INT.LT.3) GO TO 40                                 SETUP     140
        C *                                                         SFTUP     141
        C ***    ADAMS INTEGRATION ONLY.                            SETUP     142
        C *                                                         SETUP     143
              ICFES     = 0                                         SETUP     144
        C ***    STATES.                                            SETUP     145
              DO 20 I=1,NSTATES                                     SETUP     146
              RT(I)     = R(INDX1(I))                               SETUP     147
        20    CONTINUE                                              SETUP     148
        C ***    P.                                                 SETUP     149
              NL1 = NSTATES + 1                                     SFTUP     150
              NU1 = NSTATES + NPA*NPA                               SETUP     151
              I1        = INDXPD                                    SETUP     152
              DO 30 I=NL1,NU1                                       SETUP     153
              RT(I)     = R(I1)                                     SETUP     154
              I1        = I1 + 1                                    SFTUP     155
        30    CONTINUE                                              SETUP     156
        C *                                                         SETUP     157
        C ***    PE.                                                SETUP     158
        C *                                                         SFTUP     159
              NL2 = NU1 + 1                                         SETUP     160
              NU2 = NU1 + NPE*NPE                                   SETUP     161
              I1 = INDXPED                                          SETUP     162
              DO 31 I=NL2,NU2                                       SETUP     163
              RT(I) = R(I1)                                         SETUP     164
              I1 = I1 + 1                                           SETUP     165
           31 CONTINUE                                              SETUP     166
        C *                                                         SETUP     167
        C ***    PX.                                                SETUP     168
              NL3 = NU2 + 1                                         SETUP     169
              NFCU = NU2 + NPX*NPX                                  SETUP     170
              I1 = INDXPXD                                          SETUP     171
              DO 32 I=NL3,NEQU                                      SETUP     172
              RT(I) = R(I1)                                         SETUP     173
              I1 = I1 + 1                                           SETUP     174
           32 CONTINUE                                              SETUP     175
        40    RETURN                                                SETUP     176
              FND                                                   SETUP     177
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      SUBROUTINE SOLVR(F,A,N,M,P,PSI,PHI,DFLP)                          SOLVR    2
C                                                                       SCLVR    3
C   SUBRCUTINE TO SOLVE FOR P IN THE MATRIX RICCATI EQUATION,           SOLVR    4
C      P * F TRANSPOSE  +  F * P  +  A  =  0                            SOLVR    5
C            WHERE A = G * Q * G TRANSPOSE                              SOLVR    6
C                                                                       SOLVR    7
C   INPUT... F       N X N  COEFFICIENT MATRIX                          SCLVR    8
C            A       M X M  MATRIX                                      SCLVR    9
C            N       SIZE OF MATRICES                                   SCLVR   10
C            IMAX    MAXIMUM NUMBER OF ITERATIONS                       SOLVR   11
C            PSI     N X N WORKING MATRIX                               SCLVR   12
C            PHI     N X N WORKING MATRIX                               SCLVR   13
C            DELP    N X N WORKING MATRIX                               SCLVR   14
C   OUTPUT.. P       N X N  SOLUTICN MATRIX                             SCLVR   15
C                                                                       SCLVR   16
C                                                                       SCLVR   17
      DIMENSION  F(N,1), A(M,1), P(N,1)                                 SOLVR   18
      DIMENSION   PSI(N,1), PHI(N,1), DELP(N,1)                         SCLVR   19
C                                                                       SCLVR   20
C  *                                                                    SCLVR   21
C  ***   CALCULATE THE SCALAR FACTOR ALPHA                              SOLVR   22
C  *                                                                    SOLVR   23
      SUM= 0.0                                                          SOLVR   24
      DO 10  I=1,N                                                      SOLVR   25
   10 SUM= SUM + F(I,I)                                                 SCLVR   26
      ALPHA=  ABS( SUM ) / FLOAT(N)                                     SCLVR   27
      IF(ALPHA.GE.1.0) GO TO 11                                         SOLVR   28
      ALPHA= 1.1                                                        SOLVR   29
   11 CONTINUE                                                          SCLVR   30
C  *                                                                    SCLVR   31
C  ***    INITIALIZE FOR THE ITERATION LOOP                             SOLVR   32
C  *                                                                    SCLVR   33
      CALL TRANNN(F,PSI,N)                                              SOLVR   34
      DO 21 I=1,N                                                       SCLVR   35
   21 PSI(I,I)=  PSI(I,I) - ALPHA                                       SOLVR   36
      CALL MATINV(PSI,N,DET,N)                                          SCLVR   37
      IF(DET .EQ. 0.0) WRITE(6,1000)                                    SCLVR   38
 1000 FORMAT(/70H SOLVR CANNOT INVERT F MATRIX - ORIGINAL VALUES OF P WI SOLVR   39
     1LL BE RETAINED.)                                                  SOLVR   40
      IF(DET .EQ. 0.0) RETURN                                           SOLVR   41
      CALL ADDNM(PHI,A,PHI,N,M)                                         SOLVR   42
      CALL MULTNN(PHI,PSI,DELP,N)                                       SOLVR   43
C                                                                       SOLVR   44
      CALL MULTNR(PSI,2.*ALPHA,PHI,N)                                   SCLVR   45
      CALL MULTTN(PHI,DELP,P,N)                                         SCLVR   46
C                                                                       SOLVR   47
      DO 30  I=1,N                                                      SOLVR   48
   30 PHI(I,I)=  PHI(I,I) + 1.0                                         SOLVR   49
C  *                                                                    SCLVR   50
C  ***      P  =  2*ALPHA*PSIT*A*PSI                                    SOLVR   51
C  ***      PHI  =  2*ALPHA*PSI + I                                     SOLVP   52
C  *                                                                    SCLVR   53
C  *                                                                    SOLVP   54
C  ***     ITERATION LOOP  (SOLVE FOR P)                                SCLVR   55
C  *                                                                    SCLVR   56
      DO 40  LOOP=1,15                                                  SOLVR   57
C   CALCULATE CORRECTION TO PRESENT VALUF OF P.                         SOLVR   58
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      CALL MULTNN(P,PHI,PSI,M)                                            SCLVR    59
      CALL MULTTN(PHI,PSI,DELP,N)                                         SCLVR    60
C   CALCULATF NEW VALUE OF P.                                             SCLVR    61
      CALL ADDNN(P,DELP,P,N)                                              SOLVR    62
C   CHECK FOR CONVERGENCE                                                 SOLVR    63
      DO 42 K=1,N                                                         SOLVR    64
      DO 42 L=K,N                                                         SOLVR    65
      IF(P(K,L).EQ.0.0.AND.ABS(DELP(K,L)).GE.1.0E-07) GO TO 43            SOLVR    66
      IF(P(K,L) .EQ. 0.0) GO TO 42                                        SOLVR    67
      IF(ABS(DELP(K,L)/P(K,L)) .GE. 0.01) GO TO 43                        SCLVP    68
   42 CONTINUE                                                            SOLVR    69
C   CONVERGENCE.  RETURN TO CALLING PROGRAM.                              SOLVR    70
      WRITF(6,1002) LOOP                                                  SOLVR    71
 1002 FORMAT(/36H SOLVR CONVERGED ON ITERATION NUMBER,I3,1H.)             SCLVR    72
        PFTURN                                                            SPLVR    73
   43 CONTINUE                                                            SOLVR    74
C   ITERATION HAS NOT CONVERGED.                                          SOLVR    75
      CALL MULTNN(PHI,PHI,DELP,N)                                         SOLVR    76
      DO 44 I=1,N                                                         SOLVR    77
      DO 44 J=1,N                                                         SOLVR    78
   44 PHI(I,J)= DELP(I,J)                                                 SOLVR    79
   40 CONTINUE                                                            SOLVR    80
C  ***    END OF ITERATION LOOP                                           SOLVR    81
      PRINT 1001                                                          SOLVR    82
 1001 FORMAT(/63H SOLVR FAILED TO CONVERGE - P WILL BE RESET TO ORIGINAL  SOLVP    83
     1 PATRIX.)                                                           SOLVR    84
      K = N - M                                                           SOLVR    85
      DO 46 I=1,N                                                         SOLVR    86
      DO 45 J=1,N                                                         SOLVR    87
      IF(I.LT.K.OR.I.NE.J) P(I,J) = 0.0                                   SOLVR    88
   45 CONTINUE                                                            SOLVR    89
   46 CONTINUE                                                            SOLVR    90
      RETURN                                                              SOLVR    91
      END                                                                 SOLVR    92
      SURROUTINF TARRD(X,Y,NPTS)                                        TABRD      2
C ********************************************************************* TABRD      3
C ***                                                                   TABRD      4
C ***    ROUTINE TO DECOMPOSE A NONLINEAR FUNCTION INTO ELEMENTS OF ITS TABRD      5
C ***    DESCRIBING FUNCTION.  THE ARKAY *TABLE* IS USED BY SUBROUTINE  TABRD      6
C ***    DESCRIB TO COMPUTE THE GALSSIAN DESCRIBING FUNCTION (GDF).     TABRD      7
C ***                                                                   TABRD      8
C ***    X    - IN - ARRAY OF INDEPENDENT VARIABLES.                    TABRD      9
C ***    Y    - IN - ARRAY OF DEPENDENT VARIABLES.                      TABRD     10
C ***    NPTS - IN - DIMENSION OF X AND Y ARRAYS.                       TABRD     11
C ***                                                                   TABRD     12
C ********************************************************************* TABRD     13
C *                                                                     TABRD     14
C ***    DIMENSION ON T      - 2*NPTS                                   TABRD     15
C *                                                                     TABRD     16
      DIMENSION T(120),YY(2),X(NPTS),Y(NPTS)                            TABRD     17
C *                                                                     GDF        2
C ***    TABLES DECOMPOSED INTO DESCRIBING FUNCTION ELEMENTS.           GDF        3
C ***    DIMENSION ON INDEX - 4*(NUMBER OF CALLS TO TABRD)              GDF        4
C ***    DIMENSION ON TABLE - (4*(NO. OF IND. VAR.)+3)*(NO. OF CALLS TO GDF        5
C *                                                                     GDF        6
      COMMON/GDF/NTABLE,INDEX(20),TABLE(200)                            GDF        7
      DATA NTABLE,NEXT,L2 /0,1,1/                                       TABRD     19
C                                                                       TABRD     20
C *****************            STORE NON-LINEAR TABLES     ************ TABRD     21
C                                                                       TABRD     22
      NTABLE       = NTABLE + 1                                         TABRD     23
      L            = 3*(NTABLE - 1) + 1                                 TABRD     24
      INDEX(L)     = NEXT                                               TABRD     25
      INDEX(L+1)   = L2                                                 TABRD     26
      DO 30 K=1,NPTS                                                    TABRD     27
      T(K)         = X(K)                                               TABRD     28
      T(NPTS+K)    = Y(K)                                               TABRD     29
   30 CONTINUE                                                          TABRD     30
      NEXT         = NEXT + 1                                           TABRD     31
      TABLE(NEXT)  = 0.0                                                TABRD     32
      NEXT         = NEXT + 1                                           TABRD     33
      TABLE(NEXT)  = 0.0                                                TABRD     34
      L1           = NPTS                                               TABRD     35
C                                                                       TABRD     36
C ****************  FIND DESCRIBING FUNCTION BREAKPOINTS  ************ TABRD     37
C                                                                       TABRD     38
      TABLE(NEXT) = 0.0                                                 TABRD     39
      NEXT         = NEXT + 1                                           TABRD     40
      NCX          = 1                                                  TABRD     41
      IF(T(1).LT.0.0) GO TO 40                                          TABRD     42
C *                                                                     TABRD     43
C ***     ALL BREAKPOINTS ON POSITIVE X AXIS.                           TABRD     44
C *                                                                     TABRD     45
      I2           = 1                                                  TABRD     46
      IF(T(1).FO.0.0) I2 = 2                                            TABRD     47
      GO TO 110                                                         TABRD     48
   40 IF(T(L1).GT.0.0) GO TO 50                                         TABRD     49
C *                                                                     TABRD     50
C ***     ALL BREAKPOINTS CN NEGATIVE X AXIS.                           TABRD     51
C *                                                                     TABRD     52
      I1           = L1                                                 TABRD     53
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            IF(T(L1).EQ.0.0) I1 = L1 - 1                                       TABRD      54
            GO TO 130                                                          TABRD      55
      C  *                                                                     TABRD      56
      C  ***    BREAKPOINTS SPAN X AXIS.                                       TABRD      57
      C  *                                                                     TABRD      58
      50    I1             = 1                                                 TABRD      59
            I2             = L1                                                TABRD      60
      60    J              = (I1 + I2)/2                                       TABRD      61
            IF(T(J).EQ.0.0) GO TO 70                                           TABRD      62
            IF(T(J).GT.0.0) I2 = J                                             TABRD      63
            IF(T(J).LT.0.0) I1 = J                                             TABRD      64
            IF((I2-I1).EQ.1) GO TO 80                                          TABRD      65
            GO TO 60                                                           TABRD      66
      70    I1             = J - 1                                             TABRD      67
            I2             = J + 1                                             TABRD      68
      80    IF(T(I2).EQ.ABS(T(I1))) GO TO 90                                   TABRD      69
            IF(T(I2).GT.ABS(T(I1))) GO TO 100                                  TABRD      70
      C  ***    INSERT POINT FROM POSITIVE X AXIS.                             TABRD      71
            TABLE(NEXT) = T(I2)                                                TABRD      72
            NEXT           = NEXT + 1                                          TABRD      73
            NCX            = NCX + 1                                           TABRD      74
            I2             = I2 + 1                                            TABRD      75
            IF(I2.GT.L1) GO TO 130                                             TABRD      76
            GO TO 80                                                           TABRD      77
      C  ***    INSERT POSITIVE PART OF SYMMETRIC POINT.                       TABRD      78
      90    TABLE(NEXT) = T(I2)                                                TABRD      79
            NEXT           = NEXT + 1                                          TABRD      80
            NCX            = NCX + 1                                           TABRD      81
            I2             = I2 + 1                                            TABRD      82
            I1             = I1 - 1                                            TABRD      83
            IF(I1.GT.0.AND.I2.LE.L1) GO TO 80                                  TABRD      84
            IF(I1.GT.0) GO TO 130                                              TABRD      85
            IF(I2.LE.L1) GO TO 110                                             TABRD      86
            GO TO 150                                                          TABRD      87
      C  ***    INSERT POINT FROM NEGATIVE X AXIS.                             TABRD      88
      100   TABLE(NEXT) = ABS(T(I1))                                           TABRD      89
            NEXT           = NEXT + 1                                          TABRD      90
            NCX            = NCX + 1                                           TABRD      91
            I1             = I1 - 1                                            TABRD      92
            IF(I1.GT.0) GO TO 80                                               TABRD      93
      C  *                                                                     TABRD      94
      C  ***    REMAINING POINTS ON POSITIVE X AXIS.                           TABRD      95
      C  *                                                                     TABRD      96
      110   DO 120 I=I2,L1                                                     TABRD      97
            TABLE(NEXT) = T(I)                                                 TABRD      98
            NEXT           = NEXT + 1                                          TABRD      99
            NCX            = NCX + 1                                           TABRD     100
      120   CONTINUE                                                           TABRD     101
            GO TO 150                                                          TABRD     102
      C  *                                                                     TABRD     103
      C  ***    REMAINING POINTS ON NEGATIVE X AXIS.                           TABRD     104
      C  *                                                                     TABRD     105
      130   DO 140 I=1,I1                                                      TABRD     106
            TABLE(NEXT) = ABS(T(I1+1-I))                                       TABRD     107
            NEXT           = NEXT + 1                                          TABRD     108
            NCX            = NCX + 1                                           TABRD     109
      140   CONTINUE                                                           TABRD     110
      150   INDEX(L+2)  = NCX                                         TABRD     111
            NCX         = NEXT + L2                                   TABRD     112
      C                                                               TABRD     113
      C ************     COMPUTE ELEMENTS OF DESCRIBING FUNCTIONS ******* TABRD 114
      C                                                               TABRD     115
            INDX        = INDEX(L) + INDEX(L+1) + 2                   TABRD     116
            JNDX        = INDEX(L) + INDEX(L+1) + INDEX(L+2)          TABRD     117
            DO 240 I=1,L2                                             TABRD     118
            K           = L1*I                                        TABRC     119
      C *                                                             TABRD     120
      C ***     COMPUTE Y-AXIS INTERCEPT.                             TABRD     121
      C *                                                             TABRD     122
            I1          = 1                                           TABRD     123
            I2          = 2                                           TABRD     124
            IF(T(I1).GT.C.0) GO TO 170                                TABRD     125
            I1          = L1 - 1                                      TABRD     126
            I2          = L1                                          TABRD     127
            IF(T(I2).LT.0.0) GO TO 170                                TABRD     128
            I1          = 1                                           TABRD     129
      160   J           = (I1 + I2)/2                                 TABRD     130
            TABLE(NEXT) = T(K+J)                                      TABRD     131
            IF(T(J).EQ.0.0) GO TO 180                                 TABRD     132
            IF(T(J).GT.0.0) I2 = J                                    TABRD     133
            IF(T(J).LT.0.0) I1 = J                                    TABRD     134
            IF((I2-I1).GT.1) GO TO 160                                TABRD     135
      170   TABLE(NEXT) = T(I1+K) - T(I1)*(T(I2+K) - T(I1+K))/(T(I2) - T(I1)) TABRD 136
      180   NEXT        = NEXT + 1                                    TABRD     137
            YOL         = 0.0                                         TABRD     138
            YEL         = 0.0                                         TABRD     139
            XOL         = 0.0                                         TABRD     140
            DO 230 J=INDX,JNDX                                        TABRD     141
      C *                                                             TABRD     142
      C ***     COMPUTE FUNCTION VALUES AT BREAKPCINTS.               TABRD     143
      C *                                                             TABRD     144
            XX          = TABLE(J)                                    TABRD     145
            DO 220 M=1,2                                              TABRD     146
            I1          = 1                                           TABRD     147
            I2          = 2                                           TABRD     148
            IF(T(I1).GT.XX) GO TO 200                                 TABRD     149
            I1          = L1 - 1                                      TABRD     150
            I2          = L1                                          TABRD     151
            IF(T(I2).LT.XX) GO TO 200                                 TABRD     152
            I1          = 1                                           TABRD     153
      190   N           = (I1 + I2)/2                                 TABRD     154
            YY(M)       = T(K+N)                                      TABRD     155
            IF(T(N).EQ.XX) GO TO 210                                  TABRD     156
            IF(T(N).GT.XX) I2 = N                                     TABRD     157
            IF(T(N).LT.XX) I1 = N                                     TABRD     158
            IF((I2-I1).GT.1) GO TO 190                                TABRD     159
      200   YY(M)       = T(I1+K) + (XX - T(I1))*(T(I2+K) - T(I1+K))/(T(I2) - TABRD 160
           1              T(I1))                                      TABRD     161
      210   XX          = -XX                                         TABRD     162
      220   CONTINUE                                                  TABRD     163
      C *                                                             TABRD     164
      C ***     COMPUTE EVEN AND ODD COMPONENTS.                      TABRD     165
      C *                                                             TABRD     166
            YO          = 0.5*(YY(1) - YY(2))                         TABRD     167
      SUBROUTINE TLU(X,TABX,NX,TABY,NDEP,Y)                            TLU     2
C *********************************************************************** TLU     3
C ***                                                                    TLU     4
C ***   ROUTINE TO LOCK UP VALUES FOR A SET OF DEPENDENT VARIABLES        TLU     5
C ***   BASED ON A SINGLE INDEPENDENT VARIABLE.                           TLU     6
C ***                                                                    TLU     7
C ***   X    - IN  - INDEPENDENT VARIABLE (I.V.) VALUE.                  TLU     8
C ***   TABX - IN  - TABLE OF I.V. VALUES.                               TLU     9
C ***   NX   - IN  - NUMBER OF VALUES IN TABX ARRAY.                     TLU    10
C ***   TABY - IN  - TABLE OF VALUES FOR DEPENDENT VARIABLES.            TLU    11
C ***   NDEP - IN  - NUMBER OF DEPENDENT VARIABLES.                      TLU    12
C ***   Y      - OUT - DEPENDENT VARIABLE VALUE ARRAY.                   TLU    13
C ***                                                                    TLU    14
C *********************************************************************** TLU    15
      DIMENSION TABX(1),TABY(1),Y(1)                                    TLU    16
C *                                                                      TLU    17
C ***   DETERMINE IF EXTRAPOLATION NEEDED.                               TLU    18
C *                                                                      TLU    19
      K1 = 1                                                            TLU    20
      K2 = 2                                                            TLU    21
      IF(X.LT.TABX(1)) GO TO 20                                         TLU    22
      K1 = NX - 1                                                       TLU    23
      K2 = NX                                                           TLU    24
      IF(X.GT.TABX(NX)) GO TO 20                                        TLU    25
      K1 = 1                                                            TLU    26
C *                                                                      TLU    27
C ***   FIND SECTION OF TABLE TO BE INTERPOLATED.                        TLU    28
C *                                                                      TLU    29
   10 K3 = (K1 + K2)/2                                                  TLU    30
      IF(X.EQ.TABX(K3)) GO TO 40                                        TLU    31
      IF(X.GT.TABX(K3)) K1 = K3                                         TLU    32
      IF(X.LT.TABX(K3)) K2 = K3                                         TLU    33
      K3 = K2 - K1                                                      TLU    34
      IF(K3.GT.1) GO TO 10                                              TLU    35
C *                                                                      TLU    36
C ***   LINEARLY INTERPOLATE OR EXTRAPOLATE.                             TLU    37
C *                                                                      TLU    38
   20 XDUM = (X - TABX(K1))/(TABX(K2) - TABX(K1))                       TLU    39
      DO 30 I=1,NDEP                                                    TLU    40
      K3 = NX*(I - 1)                                                   TLU    41
      Y(I) = TABY(K3+K1) + XDUM*(TABY(K3+K2) - TABY(K3+K1))             TLU    42
   30 CONTINUE                                                          TLU    43
      GO TO 60                                                          TLU    44
C *                                                                      TLU    45
C ***   ENTRY IN TABLE.                                                  TLU    46
C *                                                                      TLU    47
   40 DO 50 I=1,NDEP                                                    TLU    48
      K2 = NX*(I - 1) + K3                                              TLU    49
      Y(I) = TABY(K2)                                                   TLU    50
   50 CONTINUE                                                          TLU    51
   60 RETURN                                                            TLU    52
      END                                                               TLU    53

***********        ANANIAN  //// END OF LIST ////
***********        ANANIAN  //// END OF LIST ////
```

```
                YE          = 0.5*(YY(1) + YY(2)) - TABLE(NEXT-1)          TABRD     168
          C  *                                                             TABRD     169
          C  ***    COMPUTE SLOPES.                                        TABRD     170
          C  *                                                             TABRD     171
                TABLE(NCX)  = (YO - YOL)/(TABLE(J) - XOL)                  TABRD     172
                M           = NCX + INDEX(L+2) - 1                         TABRD     173
                TABLE(M)    = (YE - YEL)/(TABLE(J) - XOL)                  TABRD     174
                YOL         = YO                                           TABRD     175
                YEL         = YE                                           TABRD     176
                XOL         = TABLE(J)                                     TABRD     177
                NCX         = NCX + 1                                      TABRD     178
            230 CONTINUE                                                   TABRD     179
                NCX         = NCX + INDEX(L+2) - 1                         TABRD     180
            240 CONTINUE                                                   TABRD     181
                NEXT        = NCX                                          TABRD     182
            250 M           = 3*NTABLE + 1                                 TABRD     183
                INDEX(M)    = NEXT                                         TABRD     184
                RETURN                                                     TABRD     185
                END                                                        TABRD     186
                YE            = 0.5*(YY(1) + YY(2)) - TABLE(NEXT-1)         TABRD     168
          C  *                                                              TABRD     169
          C  ***     COMPUTE SLOPES.                                        TABRD     170
          C  *                                                              TABRD     171
                TABLE(NCX)    = (YO - YOL)/(TABLE(J) - XOL)                 TABRD     172
                M             = NCX + INDEX(L+2) - 1                        TABRD     173
                TABLE(M)      = (YE - YEL)/(TABLE(J) - XOL)                 TABRD     174
                YOL           = YO                                          TABRD     175
                YEL           = YE                                          TABRD     176
                XOL           = TABLE(J)                                    TABRD     177
                NCX           = NCX + 1                                     TABRD     178
          230   CONTINUE                                                    TABRD     179
                NCX           = NCX + INDEX(L+2) - 1                        TABRD     180
          240   CONTINUE                                                    TABRD     181
                NEXT          = NCX                                         TABRD     182
          250   M             = 3*NTABLE + 1                                TABRD     183
                INDEX(M)      = NEXT                                        TABRD     184
                RETURN                                                      TABRD     185
                END                                                         TABRD     186
```

# APPENDIX C

## LISTING FOR OPTIMAL CONTROLLER PILOT MODEL

ONLY SUBROUTINES DEQU, MISCAL, PRØP, AND SETUP ARE LISTED, THE OTHER ROUTINES ARE THE SAME AS THE CLASSICAL PILOT MODEL (APPENDIX B)

```
          SUBROUTINE DEQU                                                        DEQU        2
C     **************************************************************************  CDEQU       3
C     ***                                                                    ***  CDEQU       4
C     ***     ROUTINE TO HANDLE SYSTEM DIFFERENTIAL EQUATIONS FOR MEANS.     ***  CDEQU       5
C     ***                                                                    ***  CDEQU       6
C     **************************************************************************  CDEQU       7
C     *                                                                          R           2
C     ***     R ARRAY SEGMENT 1 - INTEGRATION VARIABLES.                         R           3
C     *                                                                          R           4
          COMMON TIME,TO,DTIME,DTOUT,DTOUT2,TMAX                                 R           5
C     *                                                                          R           6
C     ***     R ARRAY SEGMENT 2 - DERIVATIVES.                                   R           7
C     *                                                                          R           8
          COMMON UDOT,WOOT,QDOT,TCOT,XAPPOOT,ZAPPDOT,DFRPMD,XSPDOT,              R           9
         A       ZSPDOT,TSPDOT                                                   R          10
C     *                                                                          R          11
C     ***     R ARRAY SEGMENT 3 - STATE VAPIABLES.                               R          12
C     *                                                                          R          13
          COMMON UB,WB,QB,THETA,XAPP,ZAPP,DFRPM,XSP,ZSP,THETAS                   R          14
C     *                                                                          R          15
C     ***     R ARRAY SEGMENT 4 - REF. VALUES FOR LOCAL LINEARIZATION.           R          16
C     *                                                                          R          17
          COMMON UO,WO,QO,THETAO,XAPPO,ZAPPO,XO,ZO,MO,UBASO,WBASO,WASDO,         R          18
         A       THETAAO.PSIAO,PHIAO,RCDO                                        R          19
          REAL   MO                                                              R          20
C     *                                                                          R          21
C     ***     R ARRAY SEGMENT 5 - INPUT FORCES AND MOMENTS.                      R          22
C     *                                                                          R          23
          COMMON SUMFXO,SUMFZO,SUMMO,SUMFX,DFX,SUMFZ,DFZ,SUMM,DM                 R          24
C     *                                                                          R          25
C     ***     R APRAY SEGMENT 6 - GEOMETPY.                                      R          26
C     *                                                                          R          27
          COMMON WEIGHT,G,IX,IY,IZ,IXZ,LM,WM,LTOM,LS,LTDS                        R          28
          REAL   G,IX,IY,IZ,IXZ,LM,LTOM,LS,LTDS                                  R          29
C     *                                                                          R          30
C     ***     R ARRAY SEGMENT 7 - CONSTANTS.                                     R          31
C     *                                                                          R          32
          COMMON  OMEGAU,OMEGAW,KU,KW,KFRPM,KCDN,TAUENG,TAUCDN,TAUD,             R          33
         1        KDEU,KDEW,KDEQ,KDET,KDEY,KDEZ,KDEN,KDEDE,KDEDT,                R          34
         2        KDTU,KDTW,KDTQ,KDTT,KDTX,KDTZ,KDTN,KDTDE,KDTDT                 R          35
          REAL  KU,KW,KFRPM,KCDN,                                                P          36
         1      KDEU,KDEW,KDEQ,KDET,KDEX,KDEZ,KDEN,KDEDE,KDEDT,                  R          37
         2      KDTU,KDTW,KDTQ,KDTT,KDTX,KDTZ,KDTN,KDTDE,KDTDT                   R          38
C     *                                                                          R          39
C     ***     R ARRAY SEGMENT 8 - WIND, ALTITUDE, AIRSPEED AND AIRWAKE.          R          40
C     *                                                                          R          41
          COMMON ALT,VAIR,UBAS,VBAS,WBAS,ALPHA,BETA,PSI,PHI,V5,PSI5,X1DWS,       R          42
         A       Y1DWS,VAMB,PSIAMB,X1DWA,Y1DWA,Z1DWA,VWOD,PSIWOD,PSI3,PSISP,     R          43
         B       PSIS,DX45,DY45,DZ45,XM,YM,ZM,PSIA,THETAA,PHIA,SIGMAVX,          R          44
         C       SIGMAVY,SIGMAVZ,VXAW,VYAW,VZAW,UWIND,UMEAN,UR,UAW,VWIND,        R          45
         D       VMEAN,VR,VAW,WWIND,WMEAN.WR,WAW,WNSF,PSISS,PSISC,PSIST,TS1,     R          46
         E       TS2,TS3,TS4,TS5,TR1.DXM145,DXM245,DYM145,DYM245,ZGSP,           R          47
         F       ZBIASP                                                          R          48
C     *                                                                          R          49
C     ***     R ARRAY SEGMENT 9 - OPEN LOOP PARAMETERS.                          R          50
C     *                                                                          R          51
          COMMON THETAC,DFRPMOL,DCONOL.DEOL,GAMMAGS,RANGE,VAIRC                  R          52
```

```
C  *
C  ***     R ARRAY SEGMENT 10 - AERO DATA.
C  *
      COMMON XU,XW,XQ,XFRPM,XCON,XPDIGV,XDE,ZU,ZW,ZQ,ZFRPM,ZCON,ZPDIGV,
     A       ZDE,MU,MW,MWDOT,MQ,MFRPM,MCON,MPDIGV,MDE
      REAL   MU,MW,MWDOT,MQ,MFRPM,MCON,MPDIGV,MDE
C  *
C  ***     R ARRAY SEGMENT 11
C  *
      COMMON  PC,PCD,XAPCOM,ERRX,ERRU,         ERRZ,ERRW, ETHETA
C  *
C  ***     R ARRAY SEGMENT 12 - CONTROLS.
C  *
      COMMON  DE,DT,DCON,DED,DTD,DCOND
C  *
C  ***     R ARRAY SEGMENT 13 - SPEED TABLE FOR AERO TABLE LOOKUPS.
C  *
      COMMON TABV1(6)
C  *
C  ***     R ARRAY SEGMENT 14 - SPEED TABLE FOR OPEN LOOP COMMAND TABLE LOOKUPS.
C  *
      COMMON TABV2(10)
C  *
C  ***     R ARRAY SEGMENT 15 - FLIGHT ABOVE SHIP TABLE FOR EZ LOOKUP.
C  *
      COMMON TABEZP(7)
C  *
C  ***     R ARRAY SEGMENT 16 - EZ TABLE.
C  *
      COMMON TABEZ(7)
C  *
C  ***     R ARRAY SEGMENT 17 - SHIP MOTION
C  *
      COMMON KXS,ZETAXS,WNXS,KZS,ZETAZS,WNZS,KTS,ZETATS,WNTS,
     1       KYS,ZETAYS,WNYS,KRS,ZETARS,WNRS,KPS,ZETAPS,WNPS,TAUPRT
      REAL KXS,KZS,KTS,KYS,KRS,KPS
C  *
C  ***     R ARRAY SEGMENTS 20-23 - OPEN LOOP COMMAND TABLES.
C  *
      COMMON TABTC(10)
      COMMON TRPMOL(10)
      COMMON TCONOL(10)
      COMMON TDEOL(10)
C  *
C  ***     R ARRAY SEGMENTS 24-25 - NOZZLE TABLES.
C  *
      COMMON TABR(10)
      COMMON TABRD(10)
C  *
C  ***     R ARRAY SEGMENTS 27-48 - AERO TABLES.
C  *
      COMMON TXU(6)
      COMMON TXW(6)
      COMMON TXQ(6)
      COMMON TXRPM(6)
      COMMON TXCON(6)
      COMMON TXPIGV(6)
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              COMMON TXDF(6)                                                          R     110
              COMMON TZU(6)                                                           R     111
              COMMON TZW(6)                                                           R     112
              COMMON TZQ(6)                                                           R     113
              COMMON TZRPM(6)                                                         R     114
              COMMON TZCDN(6)                                                         R     115
              COMMON TZPIGV(6)                                                        R     116
              COMMON TZDE(6)                                                          R     117
              COMMON TMU(6)                                                           R     118
              COMMON TMW(6)                                                           R     119
              COMMON TMWD(6)                                                          R     120
              COMMON TMQ(6)                                                           R     121
              COMMON TMRPM(6)                                                         R     122
              COMMON TMCDN(6)                                                         R     123
              COMMON TMPIGV(6)                                                        R     124
              COMMON TMDE(6)                                                          R     125
        C  *                                                                          R     126
        C  ***    R ARRAY SEGMENTS 50-54 - COVARIANCE MATRICIES (DO NOT OVERDIMENSION)  R     127
        C  *                                                                          R     128
              COMMON F(39,39),P(39,39),PDOT(39,39),GM(32,15),OM(15,15)                R     129
        C  *                                                                          R     130
        C  ***    P ARRAY SEGMENTS 55-56 - STANDARD DEVIATIONS.                       R     131
        C  *                                                                          R     132
              COMMON SIGMA(50)                                                        R     133
              COMMON SIGMAXY(50)                                                      R     134
        C  *                                                                          R     135
        C  ***    R ARRAY SEGMENTS 57-62 - AIRWAKE TABLES                             R     136
        C  *                                                                          R     137
              COMMON VXX(5,5,3)                                                       R     138
              COMMON VYY(5,5,3)                                                       R     139
              COMMON VZZ(5,5,3)                                                       R     140
              COMMON SVXX(5,5,3)                                                      R     141
              COMMON SVYY(5,5,3)                                                      R     142
              COMMON SVZZ(5,5,3)                                                      R     143
        C  *                                                                          R     144
        C  ***    R ARRAY SEGMENTS 63-80 - OPTIMAL CONTROLLER GAINS                   R     145
        C  *                                                                          R     146
              COMMON   TKDEU(6), TKDEW(6), TKDEQ(6), TKDET(6), TKDEX(6),              R     147
             1         TKDEZ(6), TKDEN(6), TKDEDE(6), TKDEDT(6),                      R     148
             2         TKDTU(6), TKDTW(6), TKDTQ(6), TKDTT(6), TKDTX(6),              R     149
             3         TKDTZ(6), TKDTN(6), TKDTDE(6), TKDTDT(6)                       R     150
        C  *                                                                          R     151
        C  ***    R ARRAY SEGMENTS 81-106                                             R     152
        C  *                                                                          R     153
              COMMON F1(7,7),G1(7,3),GAMMA(7,8),A(8,8),B(8,5),M1(6,6),M2(6,7),        R     154
             1       H(6,6),D(6,7),C(3,15),RL(3,3),W(5,5),VU(3,3),VY(6,6),            R     155
             2       VYI(6,6),S(3,3),FE(18,18),QE(18,18),PE(18,18),PED(18,18),        R     156
             3       KG(18,6),FXHAT(18,18),PXHAT(18,18),PXHATD(18,18),PX(18,18),      R     157
             4       CS(3,3)                                                          R     158
              REAL M1,M2,KG                                                           R     159
        C  *                                                                          R     160
        C  ***    R ARRAY SEGMENT 107 - MORE OPTIMAL CONTROLLER GAINS (NOISE RELATED)  R     161
        C  *                                                                          R     162
              COMMON   DEUR, DEWR, DEVX, DEVXD, DEVZ, DEVZD,                          R     163
             1         DTUR, DTWR, DTVX, DTVXD, DTVZ, DTVZD                           R     164
        C  *                                                                          R     165
        C  ***    R ARRAY SEGMENTS 108-119                                            R     166
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      C  *                                                                          R        167
         COMMON  TDEUR(6), TDEVR(6), TDEVX(6), TDEVXD(6), TDEVZ(6),                 R        168
        1        TDEVZD(6),  TDTUR(6), TDTVR(6), TDTVX(6), TDTVXD(6),               R        169
        2        TDTVZ(5), TDTVZD(6)                                                R        170
      C  ***************************************************************** C        R        171
      C  *                                                                          I          2
      C  ***     I ARRAY SEGMENT 1 - INTEGER VARIABLES.                             I          3
      C  *                                                                          I          4
         COMMON/INTEGER/ICEES,NEQU,NSTATES,NPA,NQM,NGM,NPE,NPX,NOAW,NOINIT          I          5
      C  *                                                                          I          6
      C  ***     I ARRAY SEGMENT 4 - DERIVATIVE INDICES.                            I          7
      C  *                                                                          I          8
         COMMON/INTEGER/ INDX1(14)                                                  I          9
      C  *                                                                          I         10
      C  ***     I ARRAY SEGMENT 5 - STATE INDICES.                                 I         11
      C  *                                                                          I         12
         COMMON/INTEGER/ INDX2(14)                                                  I         13
      C  *                                                                          I         14
      C  ***     I ARRAY SEGMENT 6 - VARIOUS INDICES.                               I         15
      C  *                                                                          I         16
         COMMON/INTEGER/ INDXPD,INDXP,INDXPED,INDXPE,INDXPXD,INDXPX                 I         17
      C                                                                            CI         18
         DATA  FLAG/0./                                                            DEQU       10
      C                                                                            DEQU       11
      C  ******************          DIFFERENTIAL EQUATIONS        *****************CDEQU      12
      C                                                                           CDEQU      13
         Q = QB - QO                                                               DEQU       14
         SINT      = SIN(THETA)                                                    DEQU       15
         COST      = COS(THETA)                                                    DEQU       16
         SPHI      = SIN(PHI)                                                      DEQU       17
         CPHI      = COS(PHI)                                                      DEQU       18
         SPSI      = SIN(PSI)                                                      DEQU       19
         CPSI      = COS(PSI)                                                      DEQU       20
      C  *                                                                         DEQU       21
      C  ***     ALTITUDE.                                                         DEQU       22
      C  *                                                                         DEQU       23
         ALT = -ZAPP                                                               DEQU       24
      C  *                                                                         DEQU       25
      C  ***     AIRPLANE W.R.T. SHIP, EARTH AXIS.                                 DEQU       26
      C  *                                                                         DEQU       27
         DX45      = XAPP - XSP                                                    DEQU       28
         DZ45      = ZAPP - ZSP                                                    DEQU       29
      C  *                                                                         DEQU       30
      C  ***     AIRPLANE W.R.T. SHIP, SHIP WIND AXIS.                             DEQU       31
      C  *                                                                         DEQU       32
         XM        = DXM145*DX45 + DXM245*DY45                                     DEQU       33
         YM        = DYM145*DX45 + DYM245*DY45                                     DEQU       34
         ZM        = DZ45                                                          DEQU       35
      C  *                                                                         DEQU       36
      C  ***     EULER ANGLES FOR AIRWAKE MODEL.                                   DEQU       37
      C  *                                                                         DEQU       38
         PSIA      = ASIN(SIN(PSI)*COS(PSI3) - COS(PSI)*SIN(PSI3))                 DEQU       39
         THETAA    = THETA                                                         DEQU       40
         PHIA      = PHI                                                           DEQU       41
      C  *                                                                         DEQU       42
      C  ***     SHIP AIRWAKE.                                                     DEQU       43
      C  *                                                                         DEQU       44
```

```
            IF(NDAW.EQ.0) CALL AIRWAKE                                              DEQU    45
      C  *                                                                          DEQU    46
      C  ***    AIRPLANE BODY AXIS COMPONENTS OF AMBIENT WIND.                      DEQU    47
      C  *                                                                          DEQU    48
            UMEAN    = X1DWA*COST*CPSI + Y1DWA*COST*SPSI - Z1DWA*SINT               DEQU    49
            VMEAN    = X1DWA*(SPHI*SINT*CPSI - CPHI*SPSI) +                         DEQU    50
           1              Y1DWA*(SPHI*SINT*SPSI + CPHI*CPSI) +                      DEQU    51
           ?              Z1DWA*SPHI*COST                                           DEQU    52
            UMEAN    = X1DWA*(CPHI*SINT*CPSI + SPHI*SPSI) +                         DEQU    53
           1              Y1DWA*(CPHI*SINT*SPSI - SPHI*CPSI) +                      DEQU    54
           2              Z1DWA*CPHI*COST                                           DEQU    55
      C  *                                                                          DEQU    56
      C  ***    WIND.                                                               DEQU    57
      C  *                                                                          DEQU    58
            UWIND    = UMEAN + UAW                                                  DEQU    59
             WWIND   =  WMEAN + WAW                                                 DEQU    60
      C   INITIALIZE INERTIAL SPEEDS FROM AIRSPEEDS, ONE TIME ONLY.                 DEQU    61
            IF(ICEES.EQ.1) UB = UBAS + UWIND                                        DEQU    62
            IF(ICEES.EQ.1) WB = WBAS + WWIND                                        DEQU    63
      C  *                                                                          DEQU    64
      C  ***    AIRSPEED.                                                           DEQU    65
      C  *                                                                          DEQU    66
            UBAS    = UB - UWIND                                                    DEQU    67
            UAS     = UBAS - UBASO                                                  DEQU    68
            WBAS    = WB - WWIND                                                    DEQU    69
            WAS     = WBAS - WBASO                                                  DEQU    70
            VAIR    = SQRT(UBAS*UBAS + WBAS*WBAS)                                   DEQU    71
            ALPHA   = ATAN2(WBAS,UBAS)                                              DEQU    72
      C  *                                                                          DEQU    73
      C  ***    LOOK UP AERO AND OPEN LOOP PARAMETERS.                              DEQU    74
      C  *                                                                          DEQU    75
            CALL TLU(VAIR,TABV1,6,TXU,22,XU)                                        DEQU    76
            CALL TLU(TIME,TABV2,10,TABTC,4,THETAC)                                  DEQU    77
            CALL TLU(VAIR,TABV1,6,TKDEU,18,KDEU)                                    DEQU    78
      C                                                                             DEQU    79
      C  NOINIT .LT. 0 INDICATES A RUN TO INITIALIZE P, VU AND VY ARRAYS BY         DEQU    80
      C  USE OF OPTION 28.  RCD MUST BE INPUT.                                      DEQU    81
      C                                                                             DEQU    82
            IF(NOINIT .LT. 0) GO TO 200                                             DEQU    83
      C  *                                                                          DEQU    84
      C  ***    SHIP.                                                               DEQU    85
      C  *                                                                          DEQU    86
            XSPDOT = V5*COS(PSI5)                                                   DEQU    87
            ZSPDOT = 0.0                                                            DEQU    88
            TSPDOT = 0.0                                                            DEQU    89
      C  *                                                                          DEQU    90
      C  ***    RANGE FROM SHIP.  RATE OF CLOSURE COMMANDS.                         DEQU    91
      C  *                                                                          DEQU    92
            RANGE    = XSP - XAPP                                                   DEQU    93
            RCD = -(37.28 - 2.33*TIME)                                              DEQU    94
            IF(TIME .GE. 16.) RCD= 0.                                               DEQU    95
            IF(TIME .GE. 16.) RC= 0.                                                DEQU    96
      C   SET A FLAG IF AIRPLANE OVERTAKES THE SHIP.                                DEQU    97
            IF(FLAG.EQ.0. .AND. XAPP.GE.XSP) FLAG=1.                                DEQU    98
            IF(FLAG.EQ.1.) RC= 0.                                                   DEQU    99
            IF(FLAG.EQ.1.) RCD= 0.                                                  DEQU   100
      C  *                                                                          DEQU   101
      C  ***    LONGITUDINAL POSITIrN ERROR.                                    DEQU   102
      C  *                                                                     DEQU   103
            XAPCOM= XSP - RC                                                    DEQU   104
            ERRX=  XAPP - XAPCOM                                                DEQU   105
            XAPPDOT = UB*COST + WB*SINT                                         DEQU   106
            ERRXD= XAPPDOT - XSPDOT + RCD                                       DEQU   107
      C  *                                                                      DEQU   108
      C  ***    GLIDE SLOPE  (POSITION AT COMMANDED RANGE)                      DEQU   109
      C  *                                                                      DEQU   110
            ZGSP = ZSP - (      RC      )*TAN(0.01745329*GAMMAGS)+ZBIASP        DEQU   111
      C  *                                                                      DEQU   112
      C  ***    VERTICAL POSITION EPROR                                         DEQU   113
      C  *                                                                      DEQU   114
            IF(FLAG.EQ.1. .OR. TIME.GT.16.) ZGSP= ZBIASP                        DEQU   115
            ERRZ=  ZAPP - ZGSP                                                  DEQU   116
            ZAPPDOT = WB*COST - UB*SINT                                         DEQU   117
            EPRZD= ZAPPDOT - ZSPDOT + (       RCD       )*TAN(.01745329*GAMMAGS)DEQU   118
      C  *                                                                      DEQU   119
      C  ***    ATTITUDE AND SPEED ERRORS                                       DEQU   120
      C  *                                                                      DEQU   121
            ETHETA= THETA - THETAC                                              DEQU   122
            COST =  COS(THETA)                                                  DEQU   123
            SINT =  SIN(THETA)                                                  DEQU   124
            ERRU =  ERRXD * COST   -   ERRZD * SINT                             DEQU   125
            EPRW =  ERRXD * SINT   +   ERRZD * COST                             DEQU   126
      C  *                                                                      DEQU   127
      C  ***    PITCH CONTROL.                                                  DEQU   128
      C  *                                                                      DEQU   129
            DED= -KDEU*ERRU  - KDEW*ERRW  - KDEQ*QB - KDET*ETHETA               DEQU   130
           1  - KDEX*ERRX - KDEZ*ERRZ - KDEN*DFRPM - KDEDE*DE - KDEDT*DT        DEQU   131
      C  *                                                                      DEQU   132
      C  ***    THRUST CONTROL.                                                 DEQU   133
      C  *                                                                      DEQU   134
            DTD= -KDTU*ERRU  - KDTW*ERRW  - KDTQ*QB - KDTT*ETHETA               DEQU   135
           1  - KDTX*ERRX - KDTZ*ERRZ - KDTN*DFRPM - KDTDE*DE - KDTDT*DT        DEQU   136
      C  *                                                                      DEQU   137
      C  ***    NOZZLE.                                                         DEQU   138
      C  *                                                                      DEQU   139
      C                                                                         DEQU   140
            DCDND= 0.                                                           DEQU   141
      C  *                                                                      DEQU   142
      C  ***    COMMANDED AIRSPEED  (HACKED FOR REFERENCE ONLY)                 DEQU   143
      C  *                                                                      DEQU   144
            RDCOM =   -RCD                                                      DEQU   145
            SINTC    = SIN(THETAC)                                              DEQU   146
            COSTC    = COS(THETAC)                                              DEQU   147
            XDC      = RDCOM + XSPDOT                                           DEQU   148
            ZDC      = XDC*TAN(.01745329*GAMMAGS)                               DEQU   149
            UASC     = COSTC*XDC - SINTC*ZDC - UWIND                            DEQU   150
            WASC     = SINTC*XDC + COSTC*ZDC - WWIND                            DEQU   151
            VAIRC    = SQRT(UASC*UASC + WASC*WASC)                              DEQU   152
      C  *                                                                      DEQU   153
      C  ***    AIRFRAME.                                                       DEQU   154
      C  *                                                                      DEQU   155
            XAPPDOT = UB*COST + WB*SINT                                         DEQU   156
            ZAPPDOT = WB*COST - UB*SINT                                         DEQU   157
            D1       = DFRPM + DFRPMCL                                          DEQU   158
      D2       = DE + DEOL                                           DEQU   159
      D3       = DCON + DCONOL                                       DEQU   160
      DFX      = XU*UAS + XW*WAS + XQ*O                              DEQU   161
      DFZ      = ZU*UAS + ZW*WAS + ZQ*O                              DEQU   162
      DM       = MU*UAS + MW*WAS + MQ*O                              DEQU   163
      SUMFX    = XO + DFX + XFRPM*D1 + XDE*D2 + XCON*D3              DEQU   164
      SUMFZ    = ZO + DFZ + ZFRPM*D1 + ZDE*D2 + ZCON*D3              DEQU   165
      SUMM     = MO + DM + MFRPM*D1 + MDE*D2 + MCON*D3               DEQU   166
      WASD     = SUMFZ + G*COST +     OB*UB                          DEQU   167
      IF(ICEES.EQ.1) WASDO = WASD                                    DEQU   168
      DM       = DM + MWDOT*(WASD - WASDO)                           DEQU   169
      SUMM     = SUMM + MWDOT*(WASD - WASDO)                         DEQU   170
      UDOT     = SUMFX - G*SINT - QB*WB                              DEQU   171
      WDOT     = SUMFZ + G*COST + QB*UB                              DEQU   172
      QDOT     = SUMM                                                DEQU   173
      TDOT     = QB                                                  DEQU   174
C  *                                                                 DEQU   175
C  ***     ENGINE.                                                   DEQU   176
C  *                                                                 DEQU   177
      DFRPMD = (KFRPM*DT - DFRPM)/TAUENG                             DEQU   178
  200 CONTINUE                                                       DEQU   179
C                                                                   CDEQU   180
C***************          UPDATE SUB O VALUES         **************CDEQU   181
C                                                                   CDEQU   182
      IF(ICEES.EQ.2) GO TO 10                                        DEQU   183
      UO       = UB                                                  DEQU   184
      WO       = WB                                                  DEQU   185
      QO       = QB                                                  DEQU   186
      THETAO   = THETA                                               DEQU   187
      XAPPO    = XAPP                                                DEQU   188
      ZAPPO    = ZAPP                                                DEQU   189
      UBASO    = UBAS                                                DEQU   190
      WBASO    = WBAS                                                DEQU   191
      WASDO    = WASD                                                DEQU   192
      XO       = XO + DFX                                            DEQU   193
      ZO       = ZO + DFZ                                            DEQU   194
      MO       = MO + DM                                             DEQU   195
      THETAAO  = THETAA                                              DEQU   196
      PSIAO    = PSIA                                                DEQU   197
      PHIAO    = PHIA                                                DEQU   198
      RCDO = RCD                                                     DEQU   199
   10 RETURN                                                         DEQU   200
      END                                                            DEQU   201
      SUBROUTINE MISCAL(NPRNT)                                          MISCAL   2
C***********************************************************************MISCAL   3
C*                                                                    * MISCAL   4
C*       SUBROUTINE FOR MISCELLANEGUS CALCULATIONS THAT DO NOT        * MISCAL   5
C*       NATURALLY OCCUR ELSEWHERE BUT ARE DESIRED FOR OUTPUT,        * MISCAL   6
C*       SUCH AS TABBING, PUNCHING, ETC., ETC.                        * MISCAL   7
C*                                                                    * MISCAL   8
C*    INPUT ARGUMENTS                                                 * MISCAL   9
C*       NPRNT      COVARIANCE MATRIX PRINT INDICATOR.                * MISCAL  10
C*                  0 = DO NOT PRINT MATRIX ON OUTPUT FILE.           * MISCAL  11
C*                                                                    * MISCAL  12
C***********************************************************************MISCAL  13
      DIMENSION CA(48)                                                  MISCAL  14
C   *                                                                   R        2
C   ***     R ARRAY SEGMENT 1 - INTEGRATION VARIABLES.                  R        3
C   *                                                                   R        4
      COMMON TIME,TC,DTIME,DTOUT,DTOUT2,TMAX                            R        5
C   *                                                                   R        6
C   ***     R ARRAY SEGMENT 2 - DERIVATIVES.                            R        7
C   *                                                                   R        8
      COMMON UDOT,WDOT,QDOT,TDOT,XAPPDOT,ZAPPDOT,DFRPMD,XSPDOT,         R        9
     A           ZSPDOT,TSPDOT                                          R       10
C   *                                                                   R       11
C   ***     R ARRAY SEGMENT 3 - STATE VARIABLES.                        R       12
C   *                                                                   R       13
      COMMON UB,WB,QB,THETA,XAPP,ZAPP,DFRPM,XSP,ZSP,THETAS              R       14
C   *                                                                   R       15
C   ***     R ARRAY SEGMENT 4 - REF. VALUES FOR LOCAL LINEARIZATION.    R       16
C   *                                                                   R       17
      COMMON UO,WO,QO,THETAO,XAPPO,ZAPPO,XO,ZO,MO,UBASO,WBASO,WASDG,    R       18
     A           THETAAO,PSIAO,PHIAO,RCDO                               R       19
      REAL    MO                                                        R       20
C   *                                                                   R       21
C   ***     R ARRAY SEGMENT 5 - INPUT FORCES AND MOMENTS.               R       22
C   *                                                                   R       23
      COMMON SUMFXO,SUMFZO,SUMMO,SUMFX,DFX,SUMFZ,DFZ,SUMM,DM            R       24
C   *                                                                   R       25
C   ***     R ARRAY SEGMENT 6 - GEOMETRY.                               R       26
C   *                                                                   R       27
      COMMON WEIGHT,G,IX,IY,IZ,IXZ,LM,WM,LTDM,LS,LTDS                   R       28
      REAL    G,IX,IY,IZ,IXZ,LM,LTDM,LS,LTDS                            R       29
C   *                                                                   R       30
C   ***     R ARRAY SEGMENT 7 - CONSTANTS.                              R       31
C   *                                                                   R       32
      COMMON  OMEGAU,OMEGAW,KU,KW,KFRPM,KCON,TAUENG,TAUCON,TAUD,        R       33
     1         KDEU,KDEW,KDEQ,KDET,KDEX,KDEZ,KDEN,KDEDE,KDEDT,          R       34
     2         KDTU,KDTW,KDTQ,KDTT,KDTX,KDTZ,KDTN,KDTDE,KDTDT           R       35
      REAL  KU,KW,KFRPM,KCON,                                           R       36
     1      KDEU,KDEW,KDEQ,KDET,KDEX,KDEZ,KDEN,KDEDE,KDEDT,             R       37
     2      KDTU,KDTW,KDTQ,KDTT,KDTX,KDTZ,KDTN,KDTDE,KDTDT              R       38
C   *                                                                   R       39
C   ***     R ARRAY SEGMENT 8 - WIND, ALTITUDE, AIRSPEED AND AIRWAKE.   R       40
C   *                                                                   R       41
      COMMON ALT,VAIR,UBAS,VBAS,WBAS,ALPHA,BETA,PSI,PHI,V5,PSI5,X1DWS,  R       42
     A           Y1DWS,VAMB,PSIAMB,X1DWA,Y1DWA,Z1DWA,VWOD,PSIWOD,PSI3,PSISP,R       43
     B           PSIS,DX45,DY45,DZ45,XM,YM,ZM,PSIA,THETAA,PHIA,SIGMAVX, R       44
     C           SIGMAVY,SIGMAVZ,VXAW,VYAW,VZAW,UWIND,UMEAN,UR,UAW,VWIND,R       45
     D      VMEAN,VR,VAW,WWIND,WMEAN,WR,WAW,WNSF,PSISS,PSISC,PSIST,TS1,     R      46
     E      TS2,TS3,TS4,TS5,TR1,DXM145,DXM245,DYM145,DYM245,ZGSP,           R      47
     F      ZBIASP                                                          R      48
C  *                                                                        R      49
C  ***    R ARRAY SEGMENT 9 - OPEN LCOP PARAMETERS.                         R      50
C  *                                                                        R      51
      COMMON THETAC,OFRPMOL,DCONOL,DEOL,GAMMAGS,RANGE,VAIRC                 R      52
C  *                                                                        R      53
C  ***    R APRAY SEGMENT 10 - AERO DATA.                                   R      54
C  *                                                                        R      55
      COMMON XU,XW,XO,XFRPM,XCON,XPDIGV,XDE,ZU,ZW,ZO,ZFRPM,ZCON,ZPDIGV,     R      56
     A      ZDE,MU,MW,MWDOT,MO,MFRFM,MCON,MPDIGV,MDE                        R      57
      REAL   MU,MW,MWDOT,MQ,MFRPM,MCON,MPCIGV,MDE                           R      58
C  *                                                                        R      59
C  ***    R ARRAY SEGMENT 11                                                R      60
C  *                                                                        R      61
      COMMON  RC,RCD,XAPCOM,ERRX,ERRU,       ERRZ,ERRW, ETHETA              R      62
C  *                                                                        R      63
C  ***    R ARRAY SEGMENT 12 - CONTROLS.                                    R      64
C  *                                                                        R      65
      COMMON  DE,DT,DCOM,DED,DTD,DCOND                                      R      66
C  *                                                                        R      67
C  ***    R ARPAY SEGMENT 13 - SPEED TABLE FOR AERO TABLE LOOKUPS.          R      68
C  *                                                                        R      69
      COMMON TABV1(6)                                                       R      70
C  *                                                                        R      71
C  ***    R ARRAY SEGMENT 14 - SPEED TABLE FOR OPEN LOOP COMMAND TABLE LOOKUPS. R    72
C  *                                                                        R      73
      COMMON TABV2(10)                                                      R      74
C  *                                                                        R      75
C  ***    R ARRAY SEGMENT 15 - FLIGHT ABOVE SHIP TABLE FOR EZ LOOKUP.       R      76
C  *                                                                        R      77
      COMMON TABEZP(7)                                                      R      78
C  *                                                                        R      79
C  ***    R ARRAY SEGMENT 16 - EZ TABLE.                                    R      80
C  *                                                                        R      81
      COMMON TABEZ(7)                                                       R      82
C  *                                                                        R      83
C  ***    R ARRAY SEGMENT 17 - SHIP MOTION                                  R      84
C  *                                                                        R      85
      COMMON KXS,ZETAXS,WNXS,KZS,ZETAZS,WNZS,KTS,ZETATS,WNTS,               R      86
     1        KYS,ZETAYS,WNYS,KRS,ZETARS,WNRS,KPS,ZETAPS,WNPS,TAUPRT        R      87
      REAL KXS,KZS,KTS,KYS,KRS,KPS                                          R      88
C  *                                                                        R      89
C  ***    R ARRAY SEGMENTS 20-23 - OPEN LOOP COMMAND TABLES.                R      90
C  *                                                                        R      91
      COMMON TABTC(10)                                                      R      92
      COMMON TRPMOL(10)                                                     R      93
      COMMON TCONOL(10)                                                     R      94
      COMMON TDEOL(10)                                                      R      95
C  *                                                                        R      96
C  ***    R ARRAY SEGMENTS 24-25 - NOZZLE TABLES.                           R      97
C  *                                                                        R      98
      COMMON TABR(10)                                                       R      99
      COMMON TABRD(10)                                                      R     100
C  *                                                                        R     101
C  ***   .R ARRAY SEGMENTS 27-48 - AERO TABLES.                             R     102
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      C  *                                                                      R     103
            COMMON TXU(6)                                                       R     104
            COMMON TXW(6)                                                       R     105
            COMMON TXO(6)                                                       R     106
            COMMON TXRPM(6)                                                     R     107
            COMMON TXCON(6)                                                     R     108
            COMMON TXPIGV(6)                                                    R     109
            COMMON TXDE(6)                                                      R     110
            COMMON TZU(6)                                                       R     111
            COMMON TZW(6)                                                       R     112
            COMMON TZQ(6)                                                       R     113
            COMMON TZRPM(6)                                                     R     114
            COMMON TZCON(6)                                                     R     115
            COMMON TZPIGV(6)                                                    R     116
            COMMON TZDE(6)                                                      R     117
            COMMON TMU(6)                                                       R     118
            COMMON TMW(6)                                                       R     119
            COMMON TMWD(6)                                                      R     120
            COMMON TMQ(6)                                                       R     121
            COMMON TMRPM(6)                                                     R     122
            COMMON TMCON(6)                                                     R     123
            COMMON TMPIGV(6)                                                    R     124
            COMMON TMDE(6)                                                      R     125
      C  *                                                                      R     126
      C  ***     R ARRAY SEGMENTS 50-54 - COVARIANCE MATRICIES (DO NOT OVERDIMENSION)  R     127
      C  *                                                                      R     128
            COMMON F(39,39),P(39,39),PDOT(39,39),GM(32,15),OM(15,15)            R     129
      C  *                                                                      R     130
      C  ***     R ARRAY SEGMENTS 55-56 - STANDARD DEVIATIONS.                  R     131
      C  *                                                                      R     132
            COMMON SIGMA(50)                                                    R     133
            COMMON SIGMAXY(50)                                                  R     134
      C  *                                                                      R     135
      C  ***     R ARRAY SEGMENTS 57-62 - AIRWAKE TABLES                        R     136
      C  *                                                                      R     137
            COMMON VXX(5,5,3)                                                   R     138
            COMMON VYY(5,5,3)                                                   R     139
            COMMON VZZ(5,5,3)                                                   R     140
            COMMON SVXX(5,5,3)                                                  R     141
            COMMON SVYY(5,5,3)                                                  R     142
            COMMON SVZZ(5,5,3)                                                  R     143
      C  *                                                                      R     144
      C  ***     R ARRAY SEGMENTS 63-80 - OPTIMAL CONTROLLER GAINS              R     145
      C  *                                                                      R     146
            COMMON  TKDEU(6), TKDEW(6), TKDEQ(6), TKDET(5), TKDEX(6),           R     147
           1        TKDEZ(6), TKDEN(6), TKDEDE(6), TKDEDT(6),                   R     148
           2        TKDTU(6), TKDTW(6), TKDTQ(6), TKDTT(6), TKDTX(6),           R     149
           3        TKDTZ(6), TKDTN(6), TKDTDE(6), TKDTDT(6)                    R     150
      C  *                                                                      R     151
      C  ***     R ARRAY SEGMENTS 81-106                                        R     152
      C  *                                                                      R     153
            COMMON F1(7,7),G1(7,3),GAMMA(7,8),A(8,8),B(8,5),M1(6,6),M2(6,7),    R     154
           1       H(6,6),D(6,7),C(3,15),RL(3,3),W(5,5),VU(3,3),VY(6,6),        R     155
           2       VYI(6,6),S(3,3),FE(18,18),QE(18,18),PE(18,18),PED(18,18),    R     156
           3       KG(18,6),FXHAT(18,18),PXHAT(18,18),PXHATD(18,18),PX(18,18),  R     157
           4       CS(3,3)                                                      R     158
            REAL M1,M2,KG                                                       R     159
      C  *                                                                      R        160
      C  ***    R ARRAY SEGMENT 107 - MORE OPTIMAL CONTROLLER GAINS (NOISE RELATED)  R    161
      C  *                                                                      R        162
            COMMON  DEUR, DEWR, DEVX, DEVXD, DEVZ, DEVZD,                       R        163
           1        DTUR, DTWR, DTVX, DTVXD, DTVZ, DTVZD                        R        164
      C  *                                                                      R        165
      C  ***    R ARRAY SEGMENTS 108-119                                        R        166
      C  *                                                                      R        167
            COMMON  TDEUR(6), TDEWR(6), TDEVX(6), TDEVXD(6), TDEVZ(6),          R        168
           1        TDEVZD(6),  TDTUR(6), TDTWR(6), TDTVX(6), TDTVXD(6),        R        169
           2        TDTVZ(6), TDTVZD(6)                                         R        170
      C  ********************************************************************  C R        171
      C  *                                                                      I          2
      C  ***    I ARRAY SEGMENT 1 - INTEGER VARIABLES.                          I          3
      C  *                                                                      I          4
            COMMON/INTEGER/ICEES,NEQU,NSTATES,NPA,NOM,NGM,NPE,NPX,NOAW,NOINIT   I          5
      C  *                                                                      I          6
      C  ***    I ARRAY SEGMENT 4 - DERIVATIVE INDICES.                         I          7
      C  *                                                                      I          8
            COMMON/INTEGER/ INDX1(14)                                           I          9
      C  *                                                                      I         10
      C  ***   .I ARRAY SEGMENT 5 - STATE INDICES.                              I         11
      C  *                                                                      I         12
            COMMON/INTEGER/ INDX2(14)                                           I         13
      C  *                                                                      I         14
      C  ***    I ARRAY SEGMENT 6 - VARIOUS INDICES.                            I         15
      C  *                                                                      I         16
            COMMON/INTEGER/ INDXPD,INDXP,INDXPED,INDXPE,INDXPXD,INDXPX          I         17
      C                                                                        CI         18
      C***********************************************************************  MISCAL  17
      C*                                                                     *  MISCAL  18
      C*        SIGMAS OF STATE VARIABLES AND OTHER TERMS.                   *  MISCAL  19
      C*                                                                     *  MISCAL  20
      C***********************************************************************  MISCAL  21
      C  *                                                                      MISCAL  22
      C  ***    STATE VARIABLES.                                                MISCAL  23
      C  *                                                                      MISCAL  24
            DO 10 I=1,NPA                                                       MISCAL  25
            SIGMA(I)= SORT(P(I,I))                                              MISCAL  26
      C    SAVE THE CROSS CORRELATION WITH X (STATE NO. 5)                      MISCAL  27
            SIGMAXY(I) = P(5,I)                                                 MISCAL  28
            CA(I)     = 0.0                                                     MISCAL  29
      10    CONTINUE                                                            MISCAL  30
            L = NPA                                                             MISCAL  31
            IF(NPRNT.EQ.0) GO TO 30                                             MISCAL  32
      C  ***      PRODUCE REQUESTED PRINT.                                      MISCAL  33
            WRITE(6,2000) TIME                                                  MISCAL  34
      2000  FORMAT(1H1,47X,27HCOVARIANCE MATRIX AT TIME =,F6.2,5H SEC.    //)   MISCAL  35
            DO 20 I=1,NPA                                                       MISCAL  36
            WRITE(6,2010) (P(I,J),J=1,NPA)                                      MISCAL  37
      2010  FORMAT(1X,8E16.6)                                                   MISCAL  38
            WRITE(6,2020)                                                       MISCAL  39
      2020  FORMAT(/)                                                           MISCAL  40
      20    CONTINUE                                                            MISCAL  41
            WRITE(6,2030) (SIGMA(I),I=1,NPA)                                    MISCAL  42
      2030  FORMAT(//35H SQUARE ROOT OF MAIN DIAGONAL TERMS     ,               MISCAL  43
           1     /(8E12.4))                                                     MISCAL  44
      WRITE(6,3000) TIME                                                MISCAL  45
 3000 FORMAT(1H1,47X,19HPE MATRIX AT TIME =,F6.2,5H SEC. //)            MISCAL  46
      DO 23 I=1,NPE                                                     MISCAL  47
      WRITE(6,2010) (PE(I,J),J=1,NPE)                                   MISCAL  48
      WRITE(6,2020)                                                     MISCAL  49
   23 CONTINUE                                                          MISCAL  50
      WRITE(6,3500) TIME                                                MISCAL  51
 3500 FORMAT(1H1,47X,≠KG MATRIX AT TIME =≠,F6.2,≠ SEC.≠ //)             MISCAL  52
      DO 25 I=1,NPE                                                     MISCAL  53
      WRITE(6,2010) (KG(I,J),J=1,6)                                     MISCAL  54
      WRITE(6,2020)                                                     MISCAL  55
   25 CONTINUE                                                          MISCAL  56
      WRITE(6,3600) TIME                                                MISCAL  57
 3600 FORMAT(1H1,47X,≠VY MATRIX AT TIME =≠,F6.2,≠ SEC.≠ //)             MISCAL  58
      DO 26 I=1,6                                                       MISCAL  59
      WRITE(6,2010) (VY(I,J),J=1,6)                                     MISCAL  60
      WRITE(6,2020)                                                     MISCAL  61
   26 CONTINUE                                                          MISCAL  62
      WRITE(6,3700) TIME                                                MISCAL  63
 3700 FORMAT(1H1,47X,≠VU MATRIX AT TIME =≠,F6.2,≠ SEC.≠ //)             MISCAL  64
      DO 27 I=1,3                                                       MISCAL  65
      WRITE(6,2010) (VU(I,J),J=1,3)                                     MISCAL  66
      WRITE(6,2020)                                                     MISCAL  67
   27 CONTINUE                                                          MISCAL  68
   30 CONTINUE                                                          MISCAL  69
C  *                                                                    MISCAL  70
C  ***     GLIDE SLOPE ERROR                                            MISCAL  71
C  *                                                                    MISCAL  72
      CA(5)    =-TAN(0.01745329*GAMMAGS)                                MISCAL  73
      CA(6)    = 1.0                                                    MISCAL  74
      L        = L + 1                                                  MISCAL  75
      SIGMA(L)= SQRT(CA(5)*CA(5)*P(5,5) + CA(5)*CA(6)*P(5,6) +          MISCAL  76
     1               CA(6)*CA(5)*P(6,5) + CA(6)*CA(6)*P(6,6))           MISCAL  77
      SIGMAXY(L) = CA(5)*P(5,5) + CA(6)*P(5,6)                          MISCAL  78
C  *                                                                    MISCAL  79
C  ***     TOUCHDOWN DISPERSION, Z DIRECTION                            MISCAL  80
C  *                                                                    MISCAL  81
      CA(6) = 1.0                                                       MISCAL  82
      CA(38) = -KZS                                                     MISCAL  83
      L = L + 1                                                         MISCAL  84
      SIGMA(L) = SQRT(CA(6)*CA(6)*P(6,6) + CA(6)*CA(38)*P(6,38) +       MISCAL  85
     *           CA(38)*CA(6)*P(38,6) + CA(38)*CA(38)*P(38,38))         MISCAL  86
      SIGMAXY(L) = CA(6)*P(5,6) + CA(38)*P(5,38)                        MISCAL  87
C*********************************************************************  MISCAL  88
C*                      END OF SIGMA HACK                            *  MISCAL  89
C*********************************************************************  MISCAL  90
C                                                                       MISCAL  91
C                                                                       MISCAL  92
      RETURN                                                            MISCAL  93
      END                                                               MISCAL  94
      SUBROUTINE PROP                                                   PROP      2
C ********************************************************************** CPROP     3
C ***                                                               *** CPROP     4
C ***    ROUTINE TO CALCULATE PERTUBATION EQNS AND PROPAGATE COVARIANCE *** CPROP 5
C ***                                                               *** CPROP     6
C ********************************************************************** CPROP     7
      DIMENSION WK1(7,18),WK2(15,32),BWRT(8,8),DOO(6,18),G2(32,32)     PROP      8
C *                                                                     R         2
C ***    R ARRAY SEGMENT 1 - INTEGRATION VARIABLES.                     R         3
C *                                                                     R         4
      COMMON TIME,TO,DTIME,DTOUT,DTOUT2,TMAX                            R         5
C *                                                                     R         6
C ***    R ARRAY SEGMENT 2 - DERIVATIVES.                               R         7
C *                                                                     R         8
      COMMON UDOT,WDOT,QDOT,TDOT,XAPPDOT,ZAPPDOT,DFRPMD,XSPDOT,          R         9
     A       ZSPDOT,TSPDOT                                              R        10
C *                                                                     R        11
C ***    R ARRAY SEGMENT 3 - STATE VARIABLES.                           R        12
C *                                                                     R        13
      COMMON UB,WB,QB,THETA,XAPP,ZAPP,DFRPM,XSP,ZSP,THETAS              R        14
C *                                                                     R        15
C ***    R ARRAY SEGMENT 4 - REF. VALUES FOR LOCAL LINEARIZATION.       R        16
C *                                                                     R        17
      COMMON UC,WO,QG,THETAO,XAPPO,ZAPPO,XO,ZO,MO,UBASO,WBASO,WASDO,    R        18
     A       THETAAO,PSIAO,PHIAO,PCDO                                   R        19
      REAL   MO                                                         R        20
C *                                                                     R        21
C ***    R ARRAY SEGMENT 5 - INPUT FORCES AND MOMENTS.                  R        22
C *                                                                     R        23
      COMMON SUMFXO,SUMFZO,SUMMO,SUMFX,DFX,SUMFZ,DFZ,SUMM,DM            R        24
C *                                                                     R        25
C ***    R ARRAY SEGMENT 6 - GEOMETRY.                                  R        26
C *                                                                     R        27
      COMMON WEIGHT,G,IX,IY,IZ,IXZ,LM,WM,LTDM,LS,LTDS                   R        28
      REAL   G,IX,IY,IZ,IXZ,LM,LTDM,LS,LTDS                             R        29
C *                                                                     R        30
C ***    R ARRAY SEGMENT 7 - CONSTANTS.                                 R        31
C *                                                                     R        32
      COMMON  OMEGAU,OMEGAW,KU,KW,KFRPM,KCDN,TAUENG,TAUCDN,TAUD,        R        33
     1        KDEU,KDEW,KDEQ,KDET,KDEX,KDEZ,KDEN,KDEDE,KDEDT,           R        34
     2        KDTU,KDTW,KDTQ,KDTT,KDTX,KDTZ,KDTN,KDTDE,KDTDT            R        35
      REAL  KU,KW,KFRPM,KCDN,                                           R        36
     1      KDEU,KDEW,KDEQ,KDET,KDEX,KDEZ,KDEN,KDEDE,KDEDT,             R        37
     2      KDTU,KDTW,KDTQ,KDTT,KDTX,KDTZ,KCTN,KDTDE,KDTDT              R        38
C *                                                                     R        39
C ***    R ARRAY SEGMENT 8 - WIND, ALTITUDE, AIRSPEED AND AIRWAKE.      R        40
C *                                                                     R        41
      COMMON ALT,VAIR,UBAS,VBAS,WBAS,ALPHA,BETA,PSI,PHI,V5,PSI5,X1DWS,  R        42
     A       Y1DWS,VAMB,PSIAMB,X1DWA,Y1DWA,Z1DWA,VWOD,PSIWOD,PSI3,PSISP, R       43
     B       PSIS,DX45,DY45,DZ45,XM,YM,ZM,PSIA,THETAA,PHIA,SIGMAVX,     R        44
     C       SIGMAVY,SIGMAVZ,VXAW,VYAW,VZAW,UWIND,UMEAN,UR,UAW,VWIND,   R        45
     D       VMEAN,VR,VAW,WWIND,WMEAN,WR,WAW,WNSF,PSISS,PSISC,PSIST,TS1, R       46
     E       TS2,TS3,TS4,TS5,TR1,DXM145,DXM245,DYM145,DYM245,ZGSP,      R        47
     F       ZBIASP                                                     R        48
C *                                                                     R        49
C ***    R ARRAY SEGMENT 9 - OPEN LOOP PARAMETEPS.                      R        50
C *                                                                     R        51
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      COMMON THETAC,DERPMOL,DCDNOL,DECL,GAMMAGS,RANGE,VAIPC                R      52
C  *                                                                         R      53
C  ***     P ARRAY SEGMENT 10 - AERO DATA.                                   R      54
C  *                                                                         R      55
      COMMON XU,XW,XQ,XFRPM,XCDN,XPDIGV,XDE,ZU,ZW,ZQ,ZFRPM,ZCDN,ZPDIGV,    R      56
     A         ZDE,MU,MW,MWDOT,MQ,MFRPM,MCDN,MPDIGV,MDE                    R      57
      REAL    MU,MW,MWDOT,MQ,MFRPM,MCDN,MPDIGV,MDE                         R      58
C  *                                                                         R      59
C  ***     R ARRAY SEGMENT 11                                                R      60
C  *                                                                         R      61
      COMMON  RC,RCD,XAPCOM,ERRX,ERRU,       ERRZ,ERRW, ETHETA              R      62
C  *                                                                         R      63
C  ***     R ARRAY SEGMENT 12 - CONTROLS.                                    R      64
C  *                                                                         R      65
      COMMON  DE,DT,DCDN,DED,DTD,DCDND                                     R      66
C  *                                                                         R      67
C  ***     R ARRAY SEGMENT 13 - SPEED TABLE FOR AERO TABLE LOOKUPS.          R      68
C  *                                                                         R      69
      COMMON TABV1(6)                                                      R      70
C  *                                                                         R      71
C  ***     R ARRAY SEGMENT 14 - SPEED TABLE FOR OPEN LOOP COMMAND TABLE LOOKUPS. R  72
C  *                                                                         R      73
      COMMON TABV2(10)                                                     R      74
C  *                                                                         R      75
C  ***     R ARRAY SEGMENT 15 - FLIGHT ABOVE SHIP TABLE FOR EZ LOOKUP.       R      76
C  *                                                                         R      77
      COMMON TABEZP(7)                                                     R      78
C  *                                                                         R      79
C  ***     R ARRAY SEGMENT 16 - EZ TABLE.                                    R      80
C  *                                                                         R      81
      COMMON TABEZ(7)                                                      R      82
C  *                                                                         R      83
C  ***     R ARRAY SEGMENT 17 - SHIP MOTION                                  R      84
C  *                                                                         R      85
      COMMON KXS,ZETAXS,WNXS,KZS,ZETAZS,WNZS,KTS,ZETATS,WNTS,              R      86
     1         KYS,ZETAYS,WNYS,KRS,ZETARS,WNRS,KPS,ZETAPS,WNPS,TAUPRT      R      87
      REAL KXS,KZS,KTS,KYS,KRS,KPS                                         R      88
C  *                                                                         R      89
C  ***     R ARRAY SEGMENTS 20-23 - OPEN LOOP COMMAND TABLES.                R      90
C  *                                                                         R      91
      COMMON TABTC(10)                                                     R      92
      COMMON TPPMOL(10)                                                    R      93
      COMMON TCDNOL(10)                                                    R      94
      COMMON TDEOL(10)                                                     R      95
C  *                                                                         R      96
C  ***     R ARRAY SEGMENTS 24-25 - NOZZLE TABLES.                           R      97
C  *                                                                         R      98
      COMMON TABR(10)                                                      R      99
      COMMON TABRD(10)                                                     R     100
C  *                                                                         R     101
C  ***     R ARRAY SEGMENTS 27-48 - AERO TABLES.                             R     102
C  *                                                                         R     103
      COMMON TXU(6)                                                        R     104
      COMMON TXW(6)                                                        R     105
      COMMON TXQ(6)                                                        R     106
      COMMON TXRPM(6)                                                      R     107
      COMMON TXCON(6)                                                      R     108
      COMMON TXPIGV(6)                                                  R     109
      COMMON TXDE(6)                                                    R     110
      COMMON TZU(6)                                                     R     111
      COMMON TZW(6)                                                     R     112
      COMMON TZQ(6)                                                     R     113
      COMMON TZRPM(6)                                                   R     114
      COMMON TZCON(6)                                                   R     115
      COMMON TZPIGV(6)                                                  R     116
      COMMON TZDE(6)                                                    R     117
      COMMON TMU(6)                                                     R     118
      COMMON TMW(6)                                                     R     119
      COMMON TMWD(6)                                                    R     120
      COMMON TMQ(6)                                                     R     121
      COMMON TMRPM(6)                                                   R     122
      COMMON TMCON(6)                                                   R     123
      COMMON TMPIGV(6)                                                  R     124
      COMMON TMDE(6)                                                    R     125
C  *                                                                    R     126
C  ***    R ARRAY SEGMENTS 50-54 - COVARIANCE MATRICIES (DO NOT OVERDIMENSION)  R     127
C  *                                                                    R     128
      COMMON F(39,39),P(39,39),PDOT(39,39),GM(32,15),QM(15,15)          R     129
C  *                                                                    R     130
C  ***    R ARRAY SEGMENTS 55-56 - STANDARD DEVIATIONS.                 R     131
C  *                                                                    R     132
      COMMON SIGMA(50)                                                  R     133
      COMMON SIGMAXY(50)                                                R     134
C  *                                                                    R     135
C  ***    R ARRAY SEGMENTS 57-62 - AIRWAKE TABLES                       R     136
C  *                                                                    R     137
      COMMON VXX(5,5,3)                                                 R     138
      COMMON VYY(5,5,3)                                                 R     139
      COMMON VZZ(5,5,3)                                                 R     140
      COMMON SVXX(5,5,3)                                                R     141
      COMMON SVYY(5,5,3)                                                R     142
      COMMON SVZZ(5,5,3)                                                R     143
C  *                                                                    R     144
C  ***    R ARRAY SEGMENTS 63-80 - OPTIMAL CONTROLLER GAINS             R     145
C  *                                                                    R     146
      COMMON  TKDEU(6), TKDEW(6), TKDEQ(6), TKDET(6), TKDEX(6),         R     147
     1        TKDEZ(6), TKDEN(6), TKDEDE(6), TKDEDT(6),                 R     148
     2        TKDTU(6), TKDTW(6), TKDTQ(6), TKDTT(6), TKDTX(6),         R     149
     3        TKDTZ(6), TKDTN(6), TKDTDE(6), TKDTDT(6)                  R     150
C  *                                                                    R     151
C  ***    R ARRAY SEGMENTS 81-106                                       R     152
C  *                                                                    R     153
      COMMON F1(7,7),G1(7,3),GAMMA(7,8),A(8,8),B(6,5),M1(6,6),M2(6,7),  R     154
     1     H(6,6),D(6,7),C(3,15),RL(3,3),W(5,5),VU(3,3),VY(6,6),        R     155
     2     VYI(6,6),S(3,3),FE(18,18),QE(18,18),PE(18,18),PED(18,18),    R     156
     3     KG(18,6),FXHAT(18,18),PXHAT(18,18),PXHATD(18,18),PX(18,18),  R     157
     4     CS(3,3)                                                      R     158
      REAL M1,M2,KG                                                     R     159
C  *                                                                    R     160
C  ***    R ARRAY SEGMENT 107 - MORE OPTIMAL CONTROLLER GAINS (NOISE RELATED)   R     161
C  *                                                                    R     162
      COMMON  DEUR, DEWR, DEVX, DEVXD, DEVZ, DEVZD,                     R     163
     1        DTUR, DTWR, DTVX, DTVXD, DTVZ, DTVZD                      R     164
C  *                                                                    R     165
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      C  ***    R ARRAY SEGMENTS 108-119                                     R       166
      C  *                                                                   R       167
            COMMON  TDEUR(6), TDEWR(6), TDEVX(6), TDEVXD(6), TDEVZ(6),       R       168
           1        TDEVZD(6),  TDTUR(6), TDTWR(6), TDTVX(6), TDTVXD(6),     R       169
           2        TDTVZ(6), TDTVZD(6)                                      R       170
      C  ********************************************************************  C  R       171
      C  *                                                                   I         2
      C  ***    I ARRAY SEGMENT 1 - INTEGER VARIABLES.                       I         3
      C  *                                                                   I         4
            COMMON/INTEGER/ICEES,NEQU,NSTATES,NPA,NQM,NGM,NPE,NPX,NQAW,NQINIT I        5
      C  *                                                                   I         6
      C  ***    I ARRAY SEGMENT 4 - DERIVATIVE INDICES.                      I         7
      C  *                                                                   I         8
            COMMON/INTEGER/ INDX1(14)                                        I         9
      C  *                                                                   I        10
      C  ***    I ARRAY SEGMENT 5 - STATE INDICES.                           I        11
      C  *                                                                   I        12
            COMMON/INTEGER/ INDX2(14)                                        I        13
      C  *                                                                   I        14
      C  ***    I ARRAY SEGMENT 6 - VARIOUS INDICES.                         I        15
      C  *                                                                   I        16
            COMMON/INTEGER/ INDXPD,INDXP,INDXPED,INDXPF,INDXPXD,INDXPX       I        17
      C                                                                     CI        18
      C  *                                                                  INTEG  2
      C  ***    TEMPORARY INTEGRATION STORAGE.                              INTEG  3
      C  ***    DIMENSION = NEQU = NSTATES + NPA**2 + NPX**2 + NPE**2       INTEG  4
      C  *                                                                  INTEG  5
            COMMON/INTEG/ RI(2187),RT(2187)                                 INTEG  6
            COSTO = COS(THETAO)                                             PROP  12
            SINTO = SIN(THETAO)                                             PROP  13
            COSSIA = COS(PSIA)                                              PROP  14
            SINSIA = SIN(PSIA)                                              PROP  15
            COSTA = COS(THETAA)                                             PROP  16
            SINTA = SIN(THETAA)                                             PROP  17
            V5CS5 = V5*COS(PSI5) - RCDO                                     PROP  18
      C *                                                                   PROP  19
      C ***     F1 MATRIX                                                   PROP  20
      C *                                                                   PROP  21
            F1(1,1) = XU                                                    PROP  22
            F1(1,2) = XW - QO                                               PROP  23
            F1(1,3) = XQ - WO                                               PROP  24
            F1(1,4) = -G*COSTO                                              PROP  25
            F1(1,7) = XFRPM                                                 PROP  26
            F1(2,1) = QO + ZU                                               PROP  27
            F1(2,2) = ZW                                                    PROP  28
            F1(2,3) = UO + ZQ                                               PROP  29
            F1(2,4) = -G*SINTO                                              PROP  30
            F1(2,7) = ZFRPM                                                 PROP  31
            F1(3,1) = MU + MWDOT*F1(2,1)                                    PROP  32
            F1(3,2) = MW + MWDOT*F1(2,2)                                    PROP  33
            F1(3,3) = MQ + MWDOT*F1(2,3)                                    PROP  34
            F1(3,4) =      MWDOT*F1(2,4)                                    PROP  35
            F1(3,7) = MFRPM + MWDOT*F1(2,7)                                 PROP  36
            F1(4,3) = 1.0                                                   PROP  37
            F1(5,1) = COSTO                                                 PROP  38
            F1(5,2) = SINTO                                                 PROP  39
            F1(5,4) = -UO*SINTO + WO*COSTO                                  PROP  40
            F1(6,1) = -SINTO                                                     PROP    41
            F1(6,2) = COSTO                                                      PROP    42
            F1(6,4) = -UO*COSTO - WO*SINTO                                       PROP    43
            F1(7,7) = -1.0/TAUENG                                                PROP    44
      C *                                                                        PROP    45
      C ***        G1 MATRIX                                                     PROP    46
      C *                                                                        PROP    47
            G1(1,1) = XDE                                                        PROP    48
            G1(1,3) = XCDN                                                       PROP    49
            G1(2,1) = ZDE                                                        PROP    50
            G1(2,3) = ZCDN                                                       PROP    51
            G1(3,1) = MDE + MWDOT*G1(2,1)                                        PROP    52
            G1(3,3) = MCDN + MWDOT*G1(2,3)                                       PROP    53
            G1(7,2) = KFRPM/TAUENG                                               PROP    54
      C *                                                                        PROP    55
      C ***        GAMMA MATRIX                                                  PROP    56
      C *                                                                        PROP    57
            GAMMA(1,1) = -XU                                                     PROP    58
            GAMMA(1,2) = -XW                                                     PROP    59
            GAMMA(1,3) = -COSSIA*(XU*COSTA + XW*SINTA)                           PROP    60
            GAMMA(1,5) = -SINSIA*(XU*COSTA + XW*SINTA)                           PROP    61
            GAMMA(1,7) = XU*SINTA - XW*COSTA                                     PROP    62
            GAMMA(2,1) = -ZU                                                     PROP    63
            GAMMA(2,2) = -ZW                                                     PROP    64
            GAMMA(2,3) = -COSSIA*(ZU*COSTA + ZW*SINTA)                           PROP    65
            GAMMA(2,5) = -SINSIA*(ZU*COSTA + ZW*SINTA)                           PROP    66
            GAMMA(2,7) = ZU*SINTA - ZW*COSTA                                     PROP    67
            GAMMA(3,1) = -MU + MWDOT*GAMMA(2,1)                                  PROP    68
            GAMMA(3,2) = -MW + MWDOT*GAMMA(2,2)                                  PROP    69
            GAMMA(3,3) = -COSSIA*(MU*COSTA + MW*SINTA) + MWDOT*GAMMA(2,3)        PROP    70
            GAMMA(3,5) = -SINSIA*(MU*COSTA + MW*SINTA) + MWDOT*GAMMA(2,5)        PROP    71
            GAMMA(3,7) = MU*SINTA - MW*COSTA + MWDOT*GAMMA(2,7)                  PROP    72
      C *                                                                        PROP    73
      C ***        A MATRIX                                                      PROP    74
      C *                                                                        PROP    75
            A(1,1) = -OMEGAU                                                     PROP    76
            A(2,2) = -OMEGAW                                                     PROP    77
            A(3,4) = 1.0                                                         PROP    78
            A(4,3) = -WNSF*WNSF                                                  PROP    79
            A(4,4) = -0.8*WNSF                                                   PROP    80
            A(5,6) = 1.0                                                         PROP    81
            A(6,5) = A(4,3)                                                      PROP    82
            A(6,6) = A(4,4)                                                      PROP    83
            A(7,8) = 1.0                                                         PROP    84
            A(8,7) = A(4,3)                                                      PROP    85
            A(8,8) = A(4,4)                                                      PROP    86
      C *                                                                        PROP    87
      C ***        B MATRIX                                                      PROP    88
      C *                                                                        PROP    89
            B(1,1) = SQRT(KU)                                                    PROP    90
            B(2,2) = SQRT(KW)                                                    PROP    91
            B(4,3) = TR1*SIGMAVX                                                 PROP    92
            B(6,4) = TR1*SIGMAVY                                                 PROP    93
            B(8,5) = TR1*SIGMAVZ                                                 PROP    94
      C *                                                                        PROP    95
      C ***        D MATRIX                                                      PROP    96
      C *                                                                        PROP    97
      D(1,1) = COSTO                                                    PROP    98
      D(1,2) = SINTO                                                    PROP    99
      D(1,4) = -UO*SINTO + WO*COSTO                                     PROP   100
      D(2,1) = -SINTO                                                   PROP   101
      D(2,2) = COSTO                                                    PROP   102
      D(2,4) = -UO*COSTO - WO*SINTO                                     PROP   103
      D(3,3) = 1.0                                                      PROP   104
      D(4,4) = 1.0                                                      PROP   105
      D(5,5) = 1.0                                                      PROP   106
      D(6,6) = 1.0                                                      PROP   107
C *                                                                     PROP   108
C ***    PX MATRIX                                                      PROP   109
C *                                                                     PROP   110
      CALL ADDNN(PXHAT,PE,PX,NPX)                                       PROP   111
C *                                                                     PROP   112
C ***     D O O MATRIX (MEASUREMENT MATRIX)                             PROP   113
C *                                                                     PROP   114
      CALL LAYIN(DOO,1,1,6,D,6,7,0)                                     PROP   115
C *                                                                     PROP   116
C ***     VY MATRIX                                                     PROP   117
C *                                                                     PROP   118
      CALL MULT(DOO,6,NPX,PX,NPX,NPX,WK1)                               PROP   119
      CALL MULTABT(WK1,6,NPX,DOO,6,NPX,VY)                              PROP   120
      DO 30 J=1,6                                                       PROP   121
      DO 25 I=1,6                                                       PROP   122
      IF(I.NE.J) VY(I,J) = 0.0                                          PROP   123
      VY(I,J) = .031415927*VY(I,J)                                      PROP   124
   25 CONTINUE                                                          PROP   125
      IF(VY(J,J).LT..1E-5) VY(J,J) = .1E-5                              PROP   126
   30 CONTINUE                                                          PROP   127
C *                                                                     PROP   128
C ***     VU MATRIX                                                     PROP   129
C *                                                                     PROP   130
      DO 50 I=1,2                                                       PROP   131
      VU(I,I) = .00942478*PX(NPX-3+I,NPX-3+I)                           PROP   132
      IF(VU(I,I).LT..3E-6) VU(I,I) = .3E-6                              PROP   133
   50 CONTINUE                                                          PROP   134
C *                                                                     PROP   135
C ***     FE MATRIX                                                     PROP   136
C *                                                                     PROP   137
      CALL LAYIN(FE,1,1,NPE,F1,7,7,0)                                   PROP   138
      CALL LAYIN(FE,1,8,NPE,GAMMA,7,8,0)                                PROP   139
      CALL LAYIN(FE,1,16,NPE,G1,7,3,0)                                  PROP   140
      CALL LAYIN(FE,8,8,NPE,A,8,8,0)                                    PROP   141
C *                                                                     PROP   142
C ***     C MATRIX                                                      PROP   143
C *                                                                     PROP   144
      CALL   TLU(VAIR,TABV1,6,TDEUR,12,DEUR)                            PROP   145
      C(1,1) = -KDEU                                                    PROP   146
      C(1,2) = -KDEW                                                    PROP   147
      C(1,3) = -KDEO                                                    PROP   148
      C(1,4) = -KDET                                                    PROP   149
      C(1,5) = -KDEX                                                    PROP   150
      C(1,6) = -KDEZ                                                    PROP   151
      C(1,7) = -KDEN                                                    PROP   152
      C(1,8) = -DEUR                                                    PROP   153
      C(1,9) = -DEWR                                                    PROP   154
      C(1,10) = -DEVX                                                   PROP  155
      C(1,11) = -DEVXD                                                  PROP  156
      C(1,14) = -DEVZ                                                   PROP  157
      C(1,15) = -DEVZD                                                  PROP  158
      C(2,1) = -KDTU                                                    PROP  159
      C(2,2) = -KDTW                                                    PROP  160
      C(2,3) = -KDTQ                                                    PROP  161
      C(2,4) = -KDTT                                                    PROP  162
      C(2,5) = -KDTX                                                    PROP  163
      C(2,6) = -KDTZ                                                    PROP  164
      C(2,7) = -KDTN                                                    PROP  165
      C(2,8)  = -DTUR                                                   PROP  166
      C(2,9)  = -DTWR                                                   PROP  167
      C(2,10) = -DTVX                                                   PROP  168
      C(2,11) = -DTVXD                                                  PROP  169
      C(2,14) = -DTVZ                                                   PROP  170
      C(2,15) = -DTVZD                                                  PROP  171
C *                                                                     PROP  172
C ***       RL MATRIX                                                   PROP  173
C *                                                                     PROP  174
      RL(1,1) = -KDEDE                                                  PROP  175
      RL(1,2) = -KDEDT                                                  PROP  176
      RL(2,1) = -KDTDE                                                  PROP  177
      RL(2,2) = -KDTDT                                                  PROP  178
C *                                                                     PROP  179
C ***     CS MATRIX                                                     PROP  180
C *                                                                     PROP  181
      CS(1,2) = -KDEU*SINTO*KZS/TAUPRT + KDEW*COSTO*KZS/TAUPRT          PROP  182
      CS(1,3) = KDEU*SINTO/TAUPRT - KDEW*COSTO/TAUPRT + KDEZ            PROP  183
      CS(2,2) = -KDTU*SINTO*KZS/TAUPRT + KDTW*COSTO*KZS/TAUPRT          PROP  184
      CS(2,3) = KDTU*SINTO/TAUPRT - KDTW*COSTO/TAUPRT + KDTZ            PROP  185
C *                                                                     PROP  186
C ***     FX HAT MATRIX                                                 PROP  187
C *                                                                     PROP  188
      CALL LAYIN(FXHAT,1,1,NPX,F1,7,7,0)                                PROP  189
      CALL LAYIN(FXHAT,1,8,NPX,GAMMA,7,8,0)                             PROP  190
      CALL LAYIN(FXHAT,1,16,NPX,G1,7,3,0)                               PROP  191
      CALL LAYIN(FXHAT,8,8,NPX,A,8,8,C)                                 PROP  192
      CALL LAYIN(FXHAT,16,1,NPX,C,3,15,0)                               PROP  193
      CALL LAYIN(FXHAT,16,16,NPX,RL,3,3,0)                              PROP  194
C *                                                                     PROP  195
C ***       QE MATRIX                                                   PROP  196
C *                                                                     PROP  197
      CALL MULT(B,8,5,W,5,5,WK1)                                        PROP  198
      CALL MULTABT(WK1,8,5,B,8,5,BWBT)                                  PROP  199
      CALL LAYIN(QE,8,8,NPE,BWBT,8,8,0)                                 PROP  200
C *                                                                     PROP  201
C ***       KG MATRIX                                                   PROP  202
C *                                                                     PROP  203
      DO 100 I=1,6                                                      PROP  204
      VYI(I,I) = 1.0/VY(I,I)                                            PROP  205
  100 CONTINUE                                                          PROP  206
      CALL MULTABT(PE,NPE,NPE,DOO,6,NPE,WK1)                            PROP  207
      CALL MULT(WK1,NPE,6,VYI,6,6,KG)                                   PROP  208
C *                                                                     PROP  209
* ***       PE DOT MATRIX                                               PROP  210
C *                                                                     PROP  211
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      CALL MULT(DCC,6,NPE,PE,NPE,NPE,WK1)                                   PROP  212
      CALL MULT(KG,NPE,6,WK1,6,NPE,WK2)                                     PROP  213
      CALL MULTNN(FE,PE,PED,NPE)                                            PROP  214
      CALL ADDTR(PED,NPE)                                                   PROP  215
      CALL ADDNN(PED,QE,PED,NPE)                                            PROP  216
      CALL SUB(PED,WK2,NPE,NPE,PED)                                         PROP  217
C *                                                                         PROP  218
C ***    PX HAT DOT MATRIX                                                  PROP  219
C *                                                                         PROP  220
      CALL MULTNN(FXHAT,PXHAT,PXHATD,NPX)                                   PROP  221
      CALL ADDTR(PXHATD,NPX)                                                PROP  222
      CALL ADDNN(PXHATD,WK2,PXHATD,NPX)                                     PROP  223
C *                                                                         PROP  224
C ***     F MATRIX                                                          PROP  225
C *                                                                         PROP  226
      CALL LAYIN(F,1,1,NPA,FE,NPE,NPE,0)                                    PROP  227
      CALL LAYIN(F,16,19,NPA,C,3,15,0)                                      PROP  228
      CALL LAYIN(F,16,34,NPA,PL,3,3,0)                                      PROP  229
      CALL LAYIN(F,16,37,NPA,CS,3,3,0)                                      PROP  230
      CALL MULT(KG,NPE,6,D,6,7,WK1)                                         PROP  231
      CALL LAYIN(F,19,1,NPA,WK1,NPE,7,0)                                    PROP  232
      CALL LAYIN(F,19,19,NPA,FE,NPE,NPE,0)                                  PROP  233
      CALL LAYIN(F,34,19,NPA,C,3,15,0)                                      PROP  234
      CALL LAYIN(F,19,19,NPA,WK1,NPE,7,-1)                                  PROP  235
      CALL LAYIN(F,34,34,NPA,RL,3,3,0)                                      PROP  236
      CALL LAYIN(F,37,37,NPA,S,3,3,0)                                       PROP  237
      CALL LAYIN(F,34,37,NPA,CS,3,3,0)                                      PROP  238
      F(16,22) = F(16,22) - KDEU*V5CS5*SINTO + KDEW*V5CS5*COSTO             PROP  239
      F(17,22) = F(17,22) - KDTU*V5CS5*SINTO + KDTW*V5CS5*COSTO             PROP  240
      F(34,22) = F(34,22) - KDEU*V5CS5*SINTO + KDEW*V5CS5*COSTO             PROP  241
      F(35,22) = F(35,22) - KDTU*V5CS5*SINTO + KDTW*V5CS5*COSTO             PROP  242
C *                                                                         PROP  243
C ***     GM MATRIX                                                         PROP  244
C *                                                                         PROP  245
      CALL LAYIN(GM,1,10,NGM,B,8,5,0)                                       PROP  246
      GM( 9,7) = 1.0                                                        PROP  247
      GM(10,8) = 1.0                                                        PROP  248
      GM(11,9) = 1.0                                                        PROP  249
      CALL LAYIN(GM,12,1,NGM,KG,NPE,6,0)                                    PROP  250
      GM(31,15) = 1.0                                                       PROP  251
C *                                                                         PROP  252
C ***     QM MATRIX                                                         PROP  253
C *                                                                         PROP  254
      CALL LAYIN(QM,1,1,NQM,VY,6,6,0)                                       PROP  255
      CALL LAYIN(QM,7,7,NQM,VU,3,3,0)                                       PROP  256
      CALL LAYIN(QM,10,10,NQM,W,5,5,0)                                      PROP  257
      QM(15,15) = 1.0                                                       PROP  258
C                                                                           PROP  259
C  *****************              PROPAGATE COVARIANCE        ************  PROP  260
C                                                                           PROP  261
      CALL MULTART(QM,NQM,NQM,GM,NGM,NQM,WK2)                               PROP  262
      CALL MULT(GM,NGM,NQM,WK2,NQM,NGM,G2)                                  PROP  263
      IF(ICEES.EQ.1.AND.NOINIT.EQ.0)                                        PROP  264
     *   CALL SOLVR(F,G2,NPA,NGM,P,PDOT,RI,RT)                              PROP  265
      CALL MULTNN(F,P,PDOT,NPA)                                             PROP  266
      CALL ADDTR(PDOT,NPA)                                                  PROP  267
      CALL ADDNM(PDOT,G2,PDOT,NPA,NGM)                                      PROP  268
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                 RETURN                                                            PROP    269
                 END                                                               PROP    270
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      SUBROUTINE SETUP(INT)                                             SETUP    2
C***********************************************************************SETUP    3
C*                                                                     *SETUP    4
C*       ROUTINE TO INITIALIZE THE INTEGRATORS AND PERFORM ONE TIME    *SETUP    5
C*       ONLY CALCULATIONS.                                            *SETUP    6
C*                                                                     *SETUP    7
C*    INPUT ARGUMENTS                                                  *SETUP    8
C*       INT        INTEGRATION OPTION.                                *SETUP    9
C*                  1 = 4 TH ORDER RUNGE-KUTTA.                        *SETUP   10
C*                  2 = 3 RD ORDER RUNGE-KUTTA.                        *SETUP   11
C*                  3 = 2 ND ORDER ADAMS.                              *SETUP   12
C*                                                                     *SETUP   13
C***********************************************************************SETUP   14
      DIMENSION R(1)                                                    SETUP   15
C  *                                                                    R        2
C  ***    R ARRAY SEGMENT 1 - INTEGRATION VARIABLES.                    R        3
C  *                                                                    R        4
      COMMON TIME,TO,DTIME,DTOUT,DTOUT2,TMAX                            R        5
C  *                                                                    R        6
C  ***    R ARRAY SEGMENT 2 - DERIVATIVES.                              R        7
C  *                                                                    R        8
      COMMON UDOT,WDOT,QDOT,TDOT,XAPPDOT,ZAPPDOT,DFRPMD,XSPDOT,         R        9
     A       ZSPDOT,TSPDOT,                                             R       10
     B       VDOT,PBDOT,RBDOT,YAPPDOT,PHIDOT,PSIDOT,YSPDOT              R       11
C  *                                                                    R       12
C  ***    R ARRAY SEGMENT 3 - STATE VARIABLES.                          R       13
C  *                                                                    R       14
      COMMON UB,WB,QB,THETA,XAPP,ZAPP,DFRPM,XSP,ZSP,THETAS,             R       15
     A        VB,PB,RB,YAPP,PHI,PSI,YSP                                 R       16
C  *                                                                    R       17
C  ***    R ARRAY SEGMENT 4 - REF. VALUES FOR LOCAL LINEARIZATION.      R       18
C  *                                                                    R       19
      COMMON UO,WO,QO,THETAO,YAPPO,ZAPPO,XO,ZO,MO,UBASO,WBASO,WASDO,    R       20
     A       THETAAO,PSIAO,PHIAO,RCDO,VO,PO,RO,YAPPO,PHIO,PSIO,YO,LO,   R       21
     B       NO,VBASO                                                   R       22
      REAL   MO,LO,NO                                                   R       23
C  *                                                                    R       24
C  ***    R ARRAY SEGMENT 5 - INPUT FORCES AND MOMENTS.                 R       25
C  *                                                                    R       26
      COMMON SUMFXO,SUMFZO,SUMMO,SUMFX,DFX,SUMFZ,DFZ,SUMM,DM,           R       27
     A       SUMFYO,SUMLO,SUMNO,SUMFY,DFY,SUML,DL,SUMN,DN               R       28
C  *                                                                    R       29
C  ***    R ARRAY SEGMENT 6 - GEOMETRY.                                 R       30
C  *                                                                    R       31
      COMMON WEIGHT,G,IX,IY,IZ,IXZ,LM,WM,LTDM,LS,LTDS                   R       32
      REAL   G,IX,IY,IZ,IXZ,LM,LTDM,LS,LTDS                             R       33
C  *                                                                    R       34
C  ***    R ARRAY SEGMENT 7 - CONSTANTS.                                R       35
C  *                                                                    R       36
      COMMON  OMEGAU,OMEGAW,KU,KW,KFRPM,KCON,TAUENG,TAUCON,TAUD,        R       37
     1         KDEU,KDEW,KDEQ,KDET,KDEX,KDEZ,KDEN,KDEDE,KDEDT,          R       38
     2         KDTU,KDTW,KDTQ,KDTT,KDTX,KDTZ,KDTN,KDTDE,KDTDT,          R       39
     3        OMEGAV,KV,TAUA,K1,K2,KY,B1,B2,TL1,TL2                     R       40
      REAL  KU,KW,KFRPM,KCON,                                           R       41
     1      KDEU,KDEW,KDEQ,KDE,T,KDEX,KDEZ,KDEN,KDEDE,KDEDT,            R       42
     2      KDTU,KDTW,KDTQ,KDTT,KDTX,KDTZ,KDTN,KDTDE,KDTDT,             R       43
     3       K1,K2,KY,KV                                                R       44
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      C  *                                                                      R  45
      C  ***    R ARRAY SEGMENT 8 - WIND, ALTITUDE, AIRSPEED AND AIPWAKE.       R  46
      C  *                                                                      R  47
            COMMON ALT,VAIR,UBAS,VBAS,WBAS,ALPHA,RETA,DUM1,DUM2,V5,PSI5,X1DWS,  R  48
           A       Y1DWS,VAMB,PSIAMB,X1DWA,Y1DWA,Z1DWA,VWOD,PSIWOD,PSI3,PSISP,  R  49
           B       PSIS,DX45,DY45,DZ45,XM,YM,ZM,PSIA,THETAA,PHIA,SIGMAVX,       R  50
           C       SIGMAVY.SIGMAVZ,VXAW,VYAW,VZAW,UWIND,UMEAN,UR,UAW,VWIND,     R  51
           D       VMEAN.VR,VAW,WWIND,WMEAN,WR,WAW,WNSF,PSISS,PSISC,PSIST,TS1,  R  52
           E       TS2,TS3,TS4,TS5,TR1,DXM145,DXM245,DYM145,DYM245,ZGSP,        R  53
           F       ZRIASP                                                       R  54
      C  *                                                                      R  55
      C  ***    R ARRAY SEGMENT 9 - OPEN LOOP PARAMFTERS.                       R  56
      C  *                                                                      R  57
            COMMON THETAC,DFRPMOL,DCONOL,DEOL,GAMMAGS,RANGE,VAIRC,              R  58
           1       DAOL,DROL                                                    R  59
      C  *                                                                      R  60
      C  ***    R ARRAY SEGMENT 10 - AERO DATA.                                 R  61
      C  *                                                                      R  62
            COMMON XU,XW,XQ,XFRPM,XCON,XPDIGV,XDE,ZU,ZW,ZQ,ZFRPM,ZCON,ZPDIGV,   R  63
           A       ZDE,MU,MW,MWDOT.MQ,MFRPM,MCON,MPDIGV,MDE,                    R  64
           B        YV,YP,YR,YDA,YDR,LV,LP,LR,LDA,LDR,NV,NP,NR,                 R  65
           C        NDA,NDR                                                     R  66
            REAL   MU,MW,MWDOT,MQ,MFRPM,MCON,MPDIGV,MDE                         R  67
            REAL  LV,LP,LR,LDA,LDR,NV,NP,NR,NDA,NDR                             R  68
      C  *                                                                      R  69
      C  ***    R ARRAY SEGMENT 11                                              R  70
      C  *                                                                      R  71
            COMMON   RC,RCD,XAPCOM,ERRX,ERRU,          ERRZ,ERRW, ETHETA,       R  72
           1         ERY,ERPHI,ERPSI,YCOM,PHICOM,PSICOM                         R  73
      C  *                                                                      R  74
      C  ***    R ARRAY SEGMENT 12 - CONTROLS.                                  R  75
      C  *                                                                      R  76
            COMMON   DE,DT,DCON,DEO,CTO,DCONO,                                  R  77
           1         DA,DR,DAP,DRP,DA1,DA2,DR1,DR2,DA1D,DA2D,DR1D,DR2D          R  78
      C  *                                                                      R  79
      C  ***    R ARRAY SEGMENT 13 - SPEED TABLE FOR AERO TABLE LOOKUPS.        R  80
      C  *                                                                      R  81
            COMMON TABV1(6)                                                     R  82
      C  *                                                                      R  83
      C  ***    R ARRAY SEGMENT 14 -  TIME TABLE FOR OPEN LOOP COMMAND TABLE LOOKUPS. R  84
      C  *                                                                      R  85
            COMMON TABV2(10)                                                    R  86
      C  *                                                                      R  87
      C  ***    R ARRAY SEGMENT 15 - UNUSED                                     R  88
      C  *                                                                      R  89
      C  *                                                                      R  90
      C  ***    R ARRAY SEGMENT 16 - GDF RELATED STUFF                          R  91
      C  *                                                                      R  92
            COMMON SIGDAP, SIGDRP, SIGDA, SIGDR, GAINDA, GAINDR                 R  93
      C  *                                                                      R  94
      C  ***    R ARRAY SEGMENT 17 - SHIP MOTION                                R  95
      C  *                                                                      R  96
            COMMON KXS,ZETAXS,WNXS.KZS,ZETAZS,WNZS,KTS,ZETATS,WNTS,             R  97
           1       KYS,ZETAYS,WNYS,KRS,ZETARS,WNRS,KPS,ZETAPS,WNPS,TAUPRT       R  98
            REAL KXS,KZS,KTS,KYS,KRS,KPS                                        R  99
      C  *                                                                      R 100
      C  ***    R ARRAY SEGMENTS 20-23.- OPEN LOOP COMMAND TAPLES.              R 101
      C  *                                                                R        102
            COMMON TABTC(10)                                              R        103
            COMMON TRPMOL(10)                                             R        104
            COMMON TCONOL(10)                                             R        105
            COMMON TDEQL(10)                                              P        106
      C  *                                                                R        107
      C  ***      R ARRAY SEGMENTS 24-25                                  R        108
      C  *                                                                R        109
            COMMON TABR(10)                                               R        110
            COMMON TABRDOT(10)                                            R        111
      C  *                                                                R        112
      C  ***      R ARRAY SEGMENTS 27-48 - LONGITUDINAL AERO DATA TABLES  R        113
      C  *                                                                R        114
            COMMON TXU(6)                                                 R        115
            COMMON TXW(6)                                                 R        116
            COMMON TXQ(6)                                                 R        117
            COMMON TXRPM(6)                                               R        118
            COMMON TXCON(6)                                               R        119
            COMMON TXPIGV(6)                                              R        120
            COMMON TXDE(6)                                                R        121
            COMMON TZU(6)                                                 R        122
            COMMON TZW(6)                                                 R        123
            COMMON TZQ(6)                                                 R        124
            COMMON TZRPM(6)                                               R        125
            COMMON TZCON(6)                                               R        126
            COMMON TZPIGV(6)                                              R        127
            COMMON TZDE(6)                                                R        128
            COMMON TMU(6)                                                 R        129
            COMMON TMW(6)                                                 R        130
            COMMON TMWD(6)                                                R        131
            COMMON TMQ(6)                                                 R        132
            COMMON TMRPM(6)                                               R        133
            COMMON TMCON(6)                                               R        134
            COMMON TMPIGV(6)                                              R        135
            COMMON TMDE(6)                                                R        136
      C  *                                                                P        137
      C  ***      R ARRAY SEGMENTS 50-54 - COVARIANCE MATRICIES (DO NOT OVERDIMENSION) R        138
      C  *                                                                R        139
            COMMON  F(17,17),P(17,17),PDOT(17,17),GM(11,4),QM(4,4)        R        140
      C  *                                                                R        141
      C  ***      R ARRAY SEGMENTS 55-56 - STANDARD DEVIATIONS.            R        142
      C  *                                                                R        143
            COMMON SIGMA(50)                                              R        144
            COMMON SIGMAXY(50)                                            R        145
      C  *                                                                R        146
      C  ***      R ARRAY SEGMENTS 57-62 - AIRWAKE TABLES                 R        147
      C  *                                                                R        148
            COMMON VXX(5,5,3)                                             R        149
            COMMON VYY(5,5,3)                                             R        150
            COMMON VZZ(5,5,3)                                             R        151
            COMMON SVXX(5,5,3)                                            R        152
            COMMON SVYY(5,5,3)                                            R        153
            COMMON SVZZ(5,5,3)                                            R        154
      C  *                                                                R        155
      C  ***      R ARRAY SEGMENTS 63-80 - OPTIMAL CONTROLLER GAINS       R        156
      C  *                                                                R        157
            COMMON  TKDEU(6), TKDEW(6), TKDEQ(6), TKDET(6), TKDEX(6),     R        158
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          1         TKDEZ(6), TKDEN(6), TKDFDE(6), TKDEDT(6),                     R        159
          2         TKDTU(6), TKDTW(6), TKDTQ(6), TKDTT(6), TKDTX(6),             R        160
          3         TKDTZ(6), TKDTN(6), TKDTDE(6), TKDTDT(6)                      R        161
    C  *                                                                          R        162
    C  ***     R ARRAY SEGMENTS 81-106                                           R        163
    C  *                                                                          R        164
          COMMON F1(6,6),G1(6,4),GAMMA(6,7),A(7,7),B(7,4),M1(1,1),M2(1,1),        R        165
          1     H(1,1),D(1,1),C(4,6),PL(4,4),W(1,1),VU(1,1),VY(1,1),              R        166
          2     VYI(1,1),S(1,1),FE(1,1),OE(1,1),PE(1,1),PED(1,1),                 R        167
          3     KG(1,1),FXHAT(1,1),PXHAT(1,1),PXHATD(1,1),PX(1,1),                R        168
          4     CS(1,1)                                                           R        169
          REAL M1,M2,KG                                                           R        170
    C  *                                                                          R        171
    C  ***     R ARRAY SEGMENT 107 - MORE OPTIMAL CONTROLLER GAINS (NOISE RELATED) R       172
    C  *                                                                          R        173
          COMMON  DEUR, DEWR, DEVX, DEVXD, DEVZ, DEVZD,                           R        174
          1       DTUR, DTWR, DTVX, DTVXD, DTVZ, DTVZD                            R        175
    C  *                                                                          P        176
    C  ***     R ARRAY SEGMENTS 108-119                                           R        177
    C  *                                                                          R        178
          COMMON  TDEUR(6), TDEWR(6), TDEVX(6), TDEVXD(6), TDEVZ(6),              R        179
          1       TDEVZD(6), TDTUR(6), TDTWR(6), TDTVX(6), TDTVXD(6),             R        180
          2       TDTVZ(6), TDTVZD(6)                                             R        181
    C *                                                                           R        182
    C ***      R ARRAY SEGMENTS 120-134 - LAT/DIR AERO DATA TABLES                R        183
    C *                                                                           R        184
          COMMON  TYV(6), TYP(6), TYR(6), TYDA(6), TYDR(6),                       R        185
          1       TLV(6), TLP(6), TLR(6), TLDA(6), TLDR(6),                       R        186
          2       TNV(6), TNP(6), TNR(6), TNDA(6), TNDR(6)                        R        187
    C *                                                                           R        188
    C ***      R ARRAY SEGMENTS 135-139 - LONG. TERMS REQD FOR LAT/DIR CASE       R        189
    C *                                                                           R        190
          COMMON  TABUB(10),TABWB(10),TXAPP(10),TZAPP(10),TXSP(10)                R        191
    C  *                                                                          R        192
    C  ***     R ARRAY SEGMENTS 140-143 - TABLES OF NONLINEAR FUNCTIONS           R        193
    C  *                                                                          R        194
          COMMON TDAIN(4), TDAOUT(4), TDRIN(4),TDROUT(4)                          R        195
    C  ****************************************************************  C        R        196
    C  *                                                                          I          2
    C  ***     I ARRAY SEGMENT 1 - INTEGER VARIABLES.                             I          3
    C  *                                                                          I          4
          COMMON/INTEGER/ICEES,NEQU,NSTATES,NPA,NQM,NGM,NPE,NPX,NOAW,NOINIT       I          5
    C  *                                                                          I          6
    C  ***     I ARRAY SEGMENT 4 - DERIVATIVE INDICES.                            I          7
    C  *                                                                          I          8
          COMMON/INTEGER/ INDX1(14)                                               I          9
    C  *                                                                          I         10
    C  ***     I ARRAY SEGMENT 5 - STATE INDICES.                                 I         11
    C  *                                                                          I         12
          COMMON/INTEGER/ INDX2(14)                                               I         13
    C  *                                                                          I         14
    C  ***     I ARRAY SEGMENT 6 - VARIOUS INDICES.                               I         15
    C  *                                                                          I         16
          COMMON/INTEGER/ INDXPD,INDXP,INDXPED,INDXPE,INDXPXD,INDXPX              I         17
    C  ****************************************************************  C        I         18
    C  *                                                                          INTEG      2
    C  ***     TEMPORARY INTEGRATION STORAGE.                                     INTEG      3
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      C  ***    DIMENSION = NEQU = NSTATES + NPA**2 + NPX**2 + NPE**2                  INTEG    4
      C  *                                                                             INTEG    5
            COMMON/INTEG/ RI(2187),PT(2187)                                            INTEG    6
      C  *                                                                             SETUP   19
      C  ***    R ARRAY EQUIVALENCE STATEMENT (PROBLEM DEPENDENT).                     SETUP   20
      C  *                                                                             SETUP   21
            EQUIVALENCE (R(1),TIME)                                                    SETUP   22
      C                                                                     C          SETUP   23
      C**************              WIND CALCULATIONS            **************C        SETUP   24
      C                                                                     C          SETUP   25
      C  *                                                                             SETUP   26
      C  ***    EARTH AXIS COMPONENTS OF AMBIENT WIND.                                 SETUP   27
      C  *                                                                             SETUP   28
            X1DWA    = VAMB*COS(PSIAMB)                                                SETUP   29
            Y1DWA    = VAMB*SIN(PSIAMB)                                                SETUP   30
      C  *                                                                             SETUP   31
      C  ***    EARTH AXIS COMPONENTS OF SHIP RELATIVE WIND.                           SETUP   32
      C  *                                                                             SETUP   33
            X1DWS    = V5*COS(PSI5 - 3.14159)                                          SETUP   34
            Y1DWS    = V5*SIN(PSI5 - 3.14159)                                          SETUP   35
      C  *                                                                             SETUP   36
      C  ***    WIND OVER DECK.                                                        SETUP   37
      C  *                                                                             SETUP   38
            VWOD     = SORT((X1DWA + X1DWS)**2 + (Y1DWA + Y1DWS)**2)                   SETUP   39
            PSIWOD   = 0.0                                                             SETUP   40
            XDUM     = X1DWA + X1DWS + Y1DWA + Y1DWS                                   SETUP   41
            IF(XDUM.NE.0.0) PSIWOD = ATAN2(Y1DWA+Y1DWS,X1DWA+X1DWS)                    SETUP   42
      C  *                                                                             SETUP   43
      C  ***    ORIENTATION OF SHIP WIND AXIS SYSTEM.                                  SETUP   44
      C  *                                                                             SETUP   45
            PSI3     = PSIWOD - 3.14159                                                SETUP   46
      C  ***    TRANSFORMATION ANGLES.                                                 SETUP   47
            PSISP    = PSI3 - PSI5                                                     SETUP   48
            TWOPI = 2.0*3.14159                                                        SETUP   49
            IF(PSISP .LT. -TWOPI) PSISP = PSISP + TWOPI                                SETUP   50
            IF(PSISP .GT. TWOPI) PSISP = PSISP - TWOPI                                 SETUP   51
            PSIS     =-PSISP                                                           SETUP   52
            TS1      = COS(PSISP)                                                      SETUP   53
            TS2      = SIN(PSISP)                                                      SETUP   54
            TS3      = COS(PSI5)                                                       SETUP   55
            TS4      = SIN(PSI5)                                                       SETUP   56
            DXM145   = TS1*TS3 - TS2*TS4                                               SETUP   57
            DXM245   = TS1*TS4 + TS2*TS3                                               SETUP   58
            DYM145   =-TS2*TS3 - TS1*TS4                                               SETUP   59
            DYM245   = TS1*TS3 - TS2*TS4                                               SETUP   60
            AWFLG = 0.0                                                                SETUP   61
            IF(VWOD.LT.32.0.OR.VWOD.GT.78.0) AWFLG = 1.0                               SETUP   62
            IF(PSIS.LT.0.50611.OR.PSIS.GT.0.89005) AWFLG = 1.0                         SETUP   63
            IF(NDAW.EQ.1) GO TO 10                                                     SETUP   64
            VEL = VWOD/1.688                                                           SETUP   65
            ANG = PSIS*57.3                                                            SETUP   66
            IF(AWFLG.NE.0.0) WRITE(6,1000) VEL,ANG                                     SETUP   67
       1000 FORMAT(1H1,*****  WARNING  ****  WARNING  ****  WARNING  ***** //          SETUP   68
           *       4X,*THE NO AIRWAKE FLAG (NDAW) HAS BEEN SET.* /                     SETUP   69
           *       1X,*VWOD OF *,F4.1,* KNOTS OR PSIS OF *,F4.1,* DEGREES*             SETUP   70
           *         *IS NOT IN THE AIRWAKE TABLE.* /                                  SETUP   71
           *       1X,*THEREFORE, THIS RUN DOES NOT HAVE AIRWAKE DATA.* //             SETUP   72
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     *        1X,***** WARNING  ****  WARNING  ****  WARNING  *****)          SETUP   73
      IF(AWFLG.NE.0.0) NOAW = 1                                               SETUP   74
      IF(AWFLG.NE.0.C) GO TO 10                                               SETUP   75
C                                                                     C       SETUP   76
C**************  AIRWAKE MODEL PRELIMINARY CALCULATIONS  **************C       SETUP   77
C                                                                     C       SETUP   78
C  *                                                                          SETUP   79
C  ***    GENERATE AIRWAKE TABLES BASED ON VWOD AND PSIS.                     SETUP   80
C  *                                                                          SETUP   81
      CALL AIRWTBL                                                            SETUP   82
C  *                                                                          SETUP   83
C  ***    SCALING RELATIONS.                                                  SETUP   84
C  *                                                                          SETUP   85
      XDUM     = 46.75/WM                                                     SETUP   86
      LS       = LM*XDUM                                                      SETUP   87
      LTDS     = LTDM*XDUM                                                    SETUP   88
      WNSF     = 1.9*XDUM*VWOD/59.15                                          SETUP   89
C  *                                                                          SETUP   90
C  ***    SHAPING TERMS.                                                      SETUP   91
C  *                                                                          SETUP   92
      PSISS    = SIN(PSIS)                                                    SETUP   93
      PSISC    = COS(PSIS)                                                    SETUP   94
      PSIST    = PSISS/PSISC                                                  SETUP   95
      TS1      = PSISS*LTDS - PSISS*LS - 23.375*PSISC                         SETUP   96
      TS2      = PSISS*LTDS + 23.375*PSISC                                    SETUP   97
      TS3      = PSISC*LTDS - PSISC*LS + 23.375*PSISS                         SETUP   98
      TS4      = 23.375/PSISS                                                 SETUP   99
      TS5      = 23.375/PSISC                                                 SETUP  100
C  *                                                                          SETUP  101
C  ***    RANDOM COMPONENT TERM.                                              SETUP  102
C  *                                                                          SETUP  103
      TR1      = SQRT(1.6*WNSF*WNSF*WNSF)                                     SETUP  104
C                                                                             SETUP  105
C**************          GDF INITIALIZATION               **************C     SETUP  106
C                                                                             SETUP  107
C  *                                                                          SETUP  108
C  ***    TABRD SETS UP TABLES FOR DESCRIBING FUNCTION SUBROUTINE             SETUP  109
C  *                                                                          SETUP  110
C    ROLL CONTROL NONLINEARITY                                                SETUP  111
      CALL TABRD(TDAIN,TDAOUT,4)                                              SETUP  112
C    YAW CONTROL NONLINEARITY                                                 SETUP  113
      CALL TABRD(TDRIN,TDROUT,4)                                              SETUP  114
C                                                                     C       SETUP  115
C**************               SET UP INTEGRATION          **************C     SETUP  116
C                                                                     C       SETUP  117
10    ICEES    = 1                                                            SETUP  118
      TIME     = TO                                                           SETUP  119
      XMASS    = WEIGHT/G                                                     SETUP  120
      YO       = SUMFYO/XMASS                                                 SETUP  121
      LO       = (IZ*SUMLO+IXZ*SUMNO)/(IX*IZ-IXZ*IXZ)                         SETUP  122
      NO       = (IX*SUMNO+IXZ*SUMLO)/(IX*IZ-IXZ*IXZ)                         SETUP  123
      UBASO    = UBAS                                                         SETUP  124
      VBASO    = VBAS                                                         SETUP  125
      WBASO    = WBAS                                                         SETUP  126
      PO =  PB                                                                SETUP  127
      RO =  RB                                                                SETUP  128
      CALL DFOU                                                               SETUP  129
      XDUM    = WNSF*WNSF
      P(7,7)  = 1.C
      P(8,8)= SIGMAVX*SIGMAVX
      P(9,9)= XDUM*P(8,8)
      P(10,10)= SIGMAVY*SIGMAVY
      P(11,11)= XDUM*P(10,10)
      P(12,12)= SIGMAVZ*SIGMAVZ
      P(13,13)= XDUM*P(12,12)
      CALL PROP
      ICEES   = 2
      IF(INT.LT.3) GO TO 40
C *
C ***     ADAMS INTEGRATION ONLY.
C *
      ICEES   = 0
C ***     STATES.
      DO 2C I=1,NSTATES
      RT(I)   = R(INDX1(I))
20    CONTINUE
C ***     P.
      NL1 = NSTATES + 1
      NU1 = NSTATES + NPA*NPA
      I1      = INDXPD
      DO 30 I=NL1,NU1
      RT(I)   = R(I1)
      I1      = I1 + 1
30    CONTINUE
C *
C ***     PE.
C *
      NL2 = NU1 + 1
      NU2 = NU1 + NPE*NPE
      I1 = INDXPED
      DO 31 I=NL2,NU2
      RT(I) = R(I1)
      I1 = I1 + 1
   31 CONTINUE
C *
C ***     PX.
      NL3 = NU2 + 1
      NEQU = NU2 + NPX*NPX
      I1 = INDXPXD
      DO 32 I=NL3,NEQU
      RT(I) = R(I1)
      I1 = I1 + 1
   32 CONTINUE
40    RETURN
      END
```

# APPENDIX D

# DESCRIBING FUNCTIONS OF GENERAL SINGLE-VALUED NONLINEARITIES REPRESENTABLE BY STRAIGHT-LINE SEGMENTS

# APPENDIX D

# DESCRIBING FUNCTIONS OF GENERAL SINGLE-VALUED NONLINEARITIES REPRESENTABLE BY STRAIGHT-LINE SEGMENTS

## D.1 Decomposition Into Odd and Even Components

The general nonlinearity is represented by N straight-line segments. The number of segments in the odd component is also N, and there are also N segments in the even component.

Denoting the general nonlinearity by $y = f(x)$: then the odd and even components are respectively given by

$$y_0(x) = 1/2 \; y(x) - y(-x)$$

$$y_E(x) = 1/2 \; y(x) + y(-x)$$

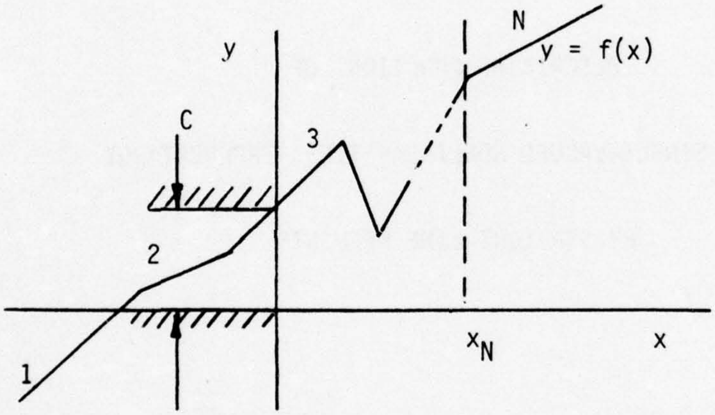

Figure D.1 General Nonlinearity Considered

Note that for $x = 0$ this gives $y_0(0) = 0$; $y_E(0) = y(0)$. It is convenient to separate out the offset C, as indicated by the following equations

$$y_0' = y_0(x) = f_0'(x)$$

$$y_E'(x) = y_E(x) - C = f_E'(x)$$

where $C = y(0)$, as shown in Figure D.1.

We split the nonlinear characteristic as indicated in Figure D.2.

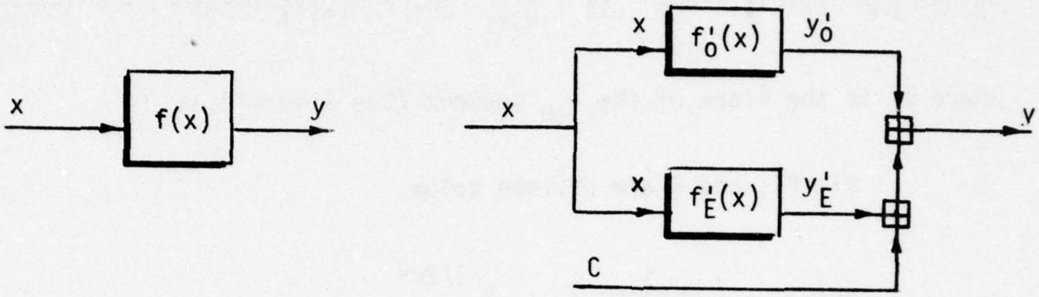

Figure D.2 Separation of the Nonlinearity Into Fven, Odd, and Bias Components

## D.2 Approximation to the Odd Component

The input is assumed to consist of a bias, B, plus a random Gaussian component of variance $\sigma^2$, denoted by $x_R$. The general form of the odd component is shown in Figure A.5.3.

$$x(t) = B + x_R(t)$$

The best least-squares approximation to $y_o'$ is

$$y_{oA}' = N_B B + N_R x_R(t)$$

where $N_B$ and $N_R$ are given by the expressions overleaf (from p. 579 of Reference D.1).

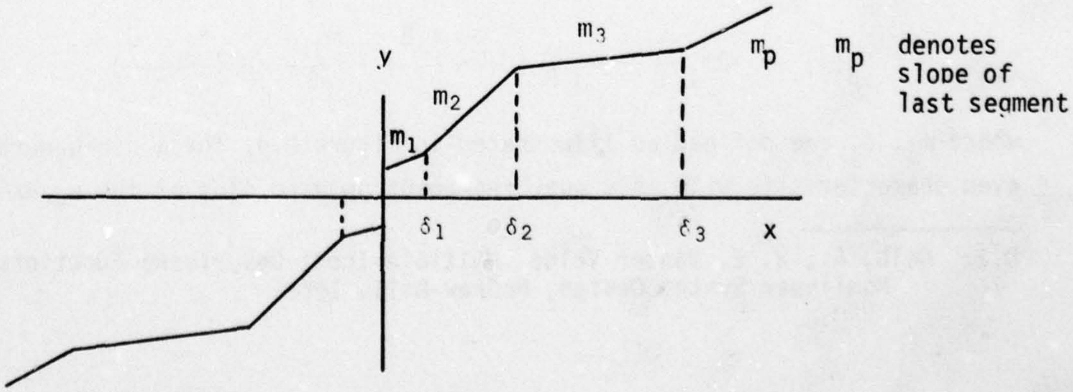

Figure D.3 General Piecewise-Linear Odd Memoryless Nonlinearity

$$N_R = 2\frac{D}{\sigma}\,PE(\frac{B}{\sigma}) + 2m_p - m_1 + \sum_{i=1}^{p-1} (m_i - m_{i+1})\left[PI(\frac{\delta_i + B}{\sigma}) + PI(\frac{\delta_i - B}{\sigma})\right]$$

$$N_B = \frac{D}{B}\left[2PI(\frac{B}{\sigma})-1\right] + 2m_p - m_1 + \frac{\sigma}{B}\sum_{i=1}^{p-1} (m_i - m_{i+1})\left[G(\frac{\delta_i + B}{\sigma}) - G(\frac{\delta_i - B}{\sigma})\right]$$

where $m_i$ is the slope of the $i_{th}$ segment (See Figure D.3)

PF, PI; and G are defined below

$$PF(w) = (\frac{1}{2\pi}) \cdot e^{-1/2w^2}$$

$$PI(w) = \int_{-\infty}^{w} PF(\Omega)\, d\Omega$$

$$G(w) = wPI(w) + PF(w)$$

Note that D = 0, because we have separated out the bias C.

### D.3 Approximation to the Even Component

The best least-squares approximation to $y_E'$ is obtained by subtracting two describing functions given on p 585 and 586 of Reference D.1. The results of subtracting describing function No. 55 from describing function No. 52 reduce to:

$$N_R(j) = m_j\, PI(\frac{\delta_j + B}{\sigma}) - m_j\, PI(\frac{\delta_j - B}{\sigma})$$

$$N_B(j) = -2m_j \frac{\delta_j}{B} + m_j \frac{\sigma}{B}\, G(\frac{\delta_j + B}{\sigma}) + \frac{m_j\, \sigma}{B}\, G(\frac{\delta_j - B}{\sigma})$$

where $m_j$, $\delta_j$ are defined as illustrated in Figure D.4, for a non-general even characteristic with only one breakpoint on each side of the $y_E$ axis.

D.1. Gelb, A., W. E. Vander Velde, Multiple-Input Describing Functions and Nonlinear System Design, McGraw-Hill, 1968.

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VOLAR: A DIGITAL COMPUTER PROGRAM FOR SIMULATING VSTOL AIRCRAFT--ETC(U)
DEC 78 J WOLKOVITCH, R B BRASSELL N62269-77-R-0389
UNCLASSIFIED 2-32000/8R-51672-VOL-2 NADC-77123-30-VOL-2 NL

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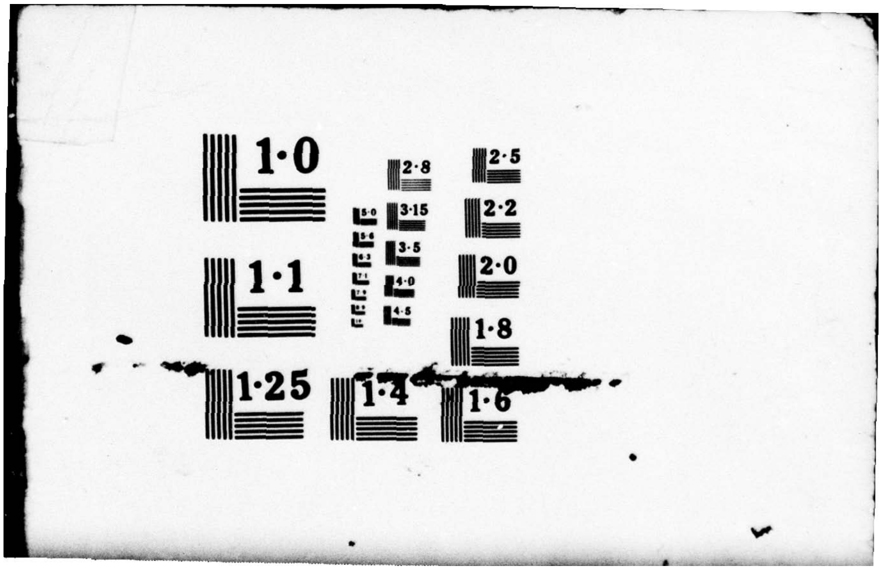
1·0
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1·6

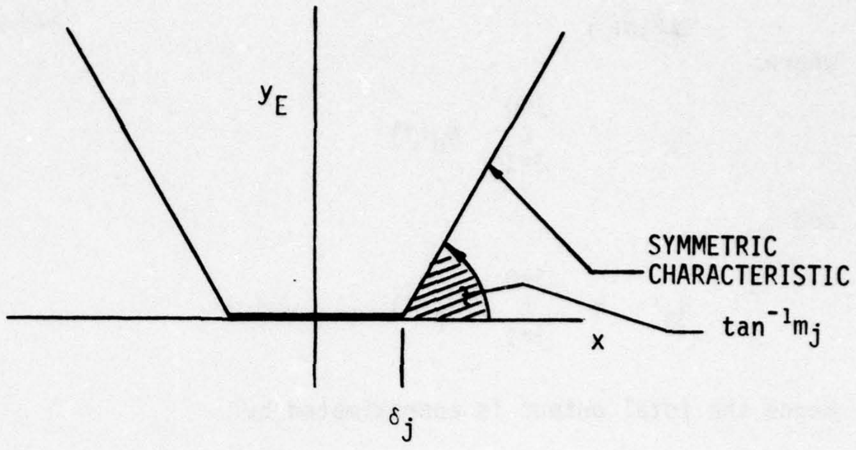

Figure D.4 Non-General Even Characteristic

In Figure D.4 $\delta_j$ is the only breakpoint. For the <u>general</u> even component there will be Q breakpoints as shown in Fiqure A.5, hence the overall approximation is:

$$y_{oA}' = N_B' \cdot B + N_R' \cdot x_R(t)$$

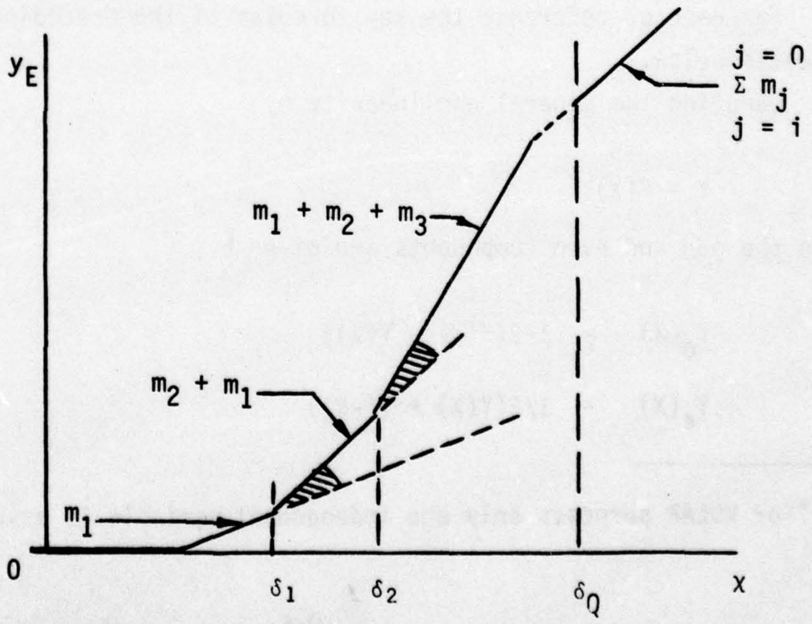

Figure D.5 General Even Characteristic with Zero Offset

where:

$$N_R' = \sum_{J=1}^{j=Q} N_R(j)$$

and

$$N_B' = \sum_{j=1}^{j=Q} N_B(j)$$

Hence the total output is approximated by:

$$y_A = B\ (N_B' + N_B) + x_R(t)(N_R' + N_R) + C$$

## D.4 Routines for Computing Describing Functions of General Single-Valued Nonlinearities Represented by Straight-Line Segments

Three FORTRAN routines, TABRD, DESCRIB and ERF provide a capability for generating describing functions for general single-valued nonlinearities which can be expressed as functions of as many as three independent variables.* One COMMON block is required to transfer data between routines. The procedures for invoking the proper routines and initializing the COMMON block are described below.

### Method

For ease of reference the key formulas of the preceding section are repeated below.

Denoting the general nonlinearity by

$$Y = F(X)$$

then the odd and even components are given by

$$Y_o(X) = 1/2(Y(X) - Y(X))$$

$$Y_e(X) = 1/2(Y(X) + Y(-X))$$

*For VOLAR purposes only one independent variable is assumed.

for X = 0, this yields

$$Y_o(0) = 0$$

$$Y_e(0) = Y(0)$$

It is convenient to separate out the offset yielding

$$Y'_o(X) = Y_o(X)$$

$$Y'_o(X) = Y_e(X) - Y(0)$$

Assuming the input consists of a bias, B, and a random Gaussian component of variance $\sigma^2$, denoted by $X_r$, the best linear least squares approximation to $y'_o$ is:

$$Y'_{o_a} = N_b\, B + N_r\, X_r(t)$$

where:

$$N_b = 2M_p - M_1 + \frac{\sigma}{B} \sum_{i=1}^{P-1} (M_i - M_{i+1}) \left[ G\left(\frac{\delta_i + B}{\sigma}\right) - G\left(\frac{\delta_i + B}{\sigma}\right) - G\left(\frac{\delta_i - B}{\sigma}\right) \right]$$

$$N_r = 2M_p - M_1 + \sum_{i=1}^{P-1} (M_i - M_{i+1}) \left[ PI\left(\frac{\delta_i + B}{\sigma}\right) + PI\left(\frac{\delta_i - B}{\sigma}\right) \right]$$

$M_i$ = Slope of the ith odd component segment

P = Index of last odd component linear segment

$$G(W) = WPI(W) + PF(W)$$

$$PI(W) = \int_{-\infty}^{W} PF(\Omega)\, d\Omega$$

$$PF(W) = \frac{1}{\sqrt{2\pi}} \quad e^{-\frac{1}{2}W^2}$$

$\delta_i$ = Max value of the first independent variable associated with the ith odd component segment

NOTE: Only segments where $\delta_i > 0$ are considered.

The best linear least squares approximation to $Y'_e$ is:

$$Y'_{e_a} = N'_b \, B + N'_r \, X_r(t)$$

where:

$$N'_r = \sum_{i=1}^{P-1} (M_{i+1} - M_i) \left[ PI\left(\frac{\delta_i + B}{\sigma}\right) - PI\left(\frac{\delta_i - B}{\sigma}\right) \right]$$

$$N'_b = \overset{P-1}{\underset{i=1}{}} (M_{i+1} - M_i) \left[ \frac{-2\delta_i}{B} + \frac{\sigma}{B}\left(G\left(\frac{\delta_i + B}{\sigma}\right) + G\left(\frac{\delta_i - B}{\sigma}\right)\right) \right]$$

$M_i$ = Slope of the ith even component segment

P = Index of last even component linear segment

G, PI, PF as defined above

$\delta_i$ = Min value of the first independent variable associated with the ith even component segment

NOTE: Only segments where $\delta_i \geq 0$ are considered.

The approximated output bias is given by

$$\overline{Y}_a = B(N_b + N'_b) + Y(0)$$

The approximated output variance is given by

$$\sigma_a^2 = \sigma^2 \, (N_r + N'_r)^2$$

## D.5 Common Block Initialization

It can be seen from the discussion on methodology above that the data that must be preserved includes:

(1) Values of the second and third independent variables for interpolation purposes.*

(2) A subset of the first indepent variable. When generating the even and odd components of the nonlinearity, the x values are symetrically disposed around $x = 0$. Once generated, only the disposed values of $x \geq 0$ need be kept.

(3) Slopes of the even and odd components corresponding to the stored values of x.

(4) The offset that was separated out of the even components.

The method of data storage within the COMMON block is discussed below.

```
CØMMØN/GDF/NTABLE,INDEX(m),TABLE(n)
```

NTABLE - Number of tables that were read.

INDEX - Array holding pointers into TABLE (must be dimensioned at least 3*NTABLE+1).

INDEX(3*(I-1)+1) - Index into TABLE where data for table I begins.

INDEX(3*(I-1)+2) - Number of values of 2nd independent variables in table I.

INDEX(3*I) - Number of saved values of x in table I.

*For VOLAR purposes only one independent variable is used. Zeros were input in the table for the second and third independent variables.

TABLE is arranged in the following manner:

| |
|---|
| DATA FOR TABLE 1 |
| DATA FOR TABLE 2 |
| ∘ |
| DATA FOR TABLE N |

| |
|---|
| $X_3$ VALUE (1 ENTRY) |
| $X_2$ VALUES<br>(INDEX(3*(I-1)+2) ENTRIES) |
| SAVED $X_1$ VALUES<br>(INDEX(3*I) ENTRIES) |
| OFFSET SEPAPATED FROM EVEN<br>COMPONENTS (INDEX(3*(I-1)+2) ENTRIES) |
| ODD COMPONENT SLOPES FOR<br>1st Y VALUE(INDEX(3*I)-1 ENTRIES) |
| EVEN COMPONENT SLOPES FOR<br>1st Y VALUE(INDEX(3*I)-1 ENTRIES) |
| ∘<br>∘ |
| ODD SLOPES FOR INDEX(3*(I-1)+2)th<br>Y VALUE (INDEX(3*I)-1 ENTRIES) |
| EVEN SLOPES FOR INDEX(3*(I-1)+2)th<br>Y VALUE(INDEX(3*I)-1 ENTRIES) |

TABLE must be dimensioned large enough to hold required data generated from all input tables.

## D.6 Routine Description

### TABRD

This routine is responsible for calculating the even and odd components of the nonlinearity, calculating the component slopes and storing the data into the COMMON block. The calling statement is:

```
CALL   TABRD(X,Y,NPTS)
```

where:

X - Array of independent variables.

Y - Array of dependent variables.

NPTS - Number of elements in the X and Y arrays.

### DESCRIB

This routine is responsible for calculating elements of the describing function. The calling statement is:

```
CALL   DESCRIB(ITAB,BIAS,SIGMA,ØBIAS,ØVAR,REPRØ)
```

where:

ITAB = Table number for which describing function is to be generated.

BIAS = Input BIAS.

SIGMA = Input SIGMA.

ØBIAS = Output BIAS.

ØVAR = Output variance.

REPRØ = Gain on output sigma.

ERF

This is an internal FUNCTION subroutine to evaluate the error function associated with the normal curve. The calling sequence is:

X = ERF(Y)

where:

Y = Upper limit of integration for the error function.

EXAMPLE: AV-8A NONLINEARITY FROM REFERENCE D.2

For checkout purposes, a describing function was generated for the CM vs ALPHA nonlinearity with DH = 6 deg, VJ/VØ = 5.4 and a 15 deg. nozzle. The following data were considered.

NOZZLE = 0 deg

| ALPHA (deg) | CM |
|---|---|
| -5 | -.14 |
| 0 | -.165 |
| 5 | -.190 |
| 10 | -.24 |
| 12 | -.27 |
| 15 | -.32 |
| 20 | 0.39 |

NOZZLE = 30 deg

| ALPHA (DEG) | CM |
|---|---|
| -5 | -.055 |
| 0 | -.024 |
| 5 | -.03 |
| 8 | -.034 |
| 10 | -.038 |
| 12 | -.042 |
| 15 | -.036 |
| 20 | -.018 |

The input, ALPHA, consisted of a bias of 10 deg. and a variance of 1 deg. The describing function yielded a mean for the output, CM, of -.139988 and a variance of 0.000052097. An alternate method of inputting 1000 Gaussian-distributed random numbers with a mean of 10 and a variance of 1 was checked yielding an output mean for CM of -.14 and a variance of 0.00005279.

D.2. Nave, R. L., "Progress Toward a Computerized VSTOL/Small Platform Landing Dynamics Investigation Model," NADC Report 77024-30, 1977.

## REFERENCES

D.1. Gelb, A., and W. E. Vander Velde, Multiple-Input Describing Functions and Nonlinear System Design, McGraw-Hill, 1968.

D.2. Nave, R. L., "Progress Toward a Computerized VSTOL/Small Platform Landing Dynamics Investigation Model," NADC Report 77024-30, 1977.

# APPENDIX E

# THE I AND R ARRAYS

## E.1 The I Array

| I ARRAY | | VARIABLE | DESCRIPTION |
|---|---|---|---|
| SEGMENT | ELEMENT | NAME | |
| 1 | 1 | ICEES | An internal 'flag' to keep track of what stage the integration is in and to identify the very first pass through the program (ICEES = 1). |
| 1 | 2 | NEQU | Total number of differential equations to integrate. |
| 1 | 3 | NSTATES | Number of mean equations to integrate. |
| 1 | 4 | NPA | Order of the P matrix (NPA by NPA). |
| 1 | 5 | NQM | Order of the QM matrix (NQM by NQM). |
| 1 | 6 | NGM | Row dimension of GM matrix (NGM by NQM). |
| 1 | 7 | NPE | Order of the PE matrix (NPE by NPE). |
| 1 | 8 | NPX | Order of the PXHAT matrix (NPX by NPX). |
| 1 | 9 | NØAW | User specified control of airwake calculations.<br>NØAW = 0, calculate airwake<br>NØAW = 1, no airwake calculations desired |
| 1 | 10 | NØINIT | User specified control of program flow<br>NØINIT = -1, fix means and integrate covariance matrices only<br>NØINIT = 0, call SOLVR to calculate steady state value of P at the conditions defined by means<br>NØINIT = 1, no special initialization calculations desired - run a normal time history |

| I ARRAY SEGMENT | ELEMENT | VARIABLE NAME | DESCRIPTION |
|---|---|---|---|
| 4 | 1-14 | INDX1 | R array locations of elements to be integrated. Setup by Option 6. |
| 5 | 1-14 | INDX2 | R array locations of elements that are the outputs of integrators. Setup by Option 6. |

| I ARRAY | | VARIABLE | DESCRIPTION |
|---|---|---|---|
| SEGMENT | ELEMENT | NAME | |
| 6 | 1 | INDXPD | R array location of the first element of the PDØT matrix. Setup by Option 6. |
| 6 | 2 | INDXP | R array location of the first element of the P matrix. Setup by Option 6. |
| 6 | 3 | INDXPED | R array location of the first element of the PED matrix. Setup by Option 6. |
| 6 | 4 | INDXPE | R array location of the first element of the PE matrix. Setup by Option 6. |
| 6 | 5 | INDXPXD | R array location of the first element of the PXHATD matrix. Setup by Option 6. |
| 6 | 6 | INDXPX | R array location of the first element of the PXHAT matrix. Setup by Option 6. |

E.2 The R Array

| R ARRAY |  | VARIABLE | UNITS | DESCRIPTION |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME |  |  |
| 1 | 1 | TIME | t | Time |
| 1 | 2 | TO | t | Initial time; time for which reference values are defined |
| 1 | 3 | DTIME | t | Integration interval |
| 1 | 4 | DTØUT | t | Output file written every DTØUT seconds |
| 1 | 5 | DTØUT2 | t | Print interval for MISCAL output |
| 1 | 6 | TMAX | t | Upper integration limit |

| R ARRAY | | VARIABLE | UNITS | DESCRIPTION |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME | | |
| 3 | 1 | UB | l/t | Inertial speed along airplane X body axis |
| 3 | 2 | WB | l/t | Inertial speed along airplane Z body axis |
| 3 | 3 | QB | rad/t | Airplane pitch rate |
| 3 | 4 | THETA | rad | Airplane pitch attitude |
| 3 | 5 | XAPP | l | Airplane position, X earth axis |
| 3 | 6 | ZAPP | l | Airplane position, Z earth axis |
| 3 | 7 | DFRPM | rpm | Engine rpm |
| 3 | 8 | XSP | l | Ship position, X earth axis |
| 3 | 9 | THETAS | rad | Ship pitch attitude |
| 3 | 10 | VB | l/t | Inertial speed along airplane Y body axis |
| 3 | 11 | PB | rad/t | Airplane roll rate |
| 3 | 12 | RB | rad/t | Airplane yaw rate |
| 3 | 13 | YAPP | l | Airplane position, Y earth axis |
| 3 | 14 | PHI | rad | Airplane roll attitude |
| 3 | 15 | PSI | rad | Airplane heading |
| 3 | 16 | YSP | l | Ship position, Y earth axis |

| SEGMENT | R ARRAY<br>ELEMENT | VARIABLE<br>NAME | UNITS | DESCRIPTION |
|---|---|---|---|---|
| 2 | 1 | UDØT | $1/t^2$ | Airplane acceleration along X body axis |
| 2 | 2 | WDØT | $1/t^2$ | Airplane acceleration along Z body axis |
| 2 | 3 | QDØT | $rad/t^2$ | Airplane pitch acceleration |
| 2 | 4 | TDØT | rad/t | Airplane pitch attitude rate-of-change |
| 2 | 5 | XAPPDØT | 1/t | Airplane velocity along X earth axis |
| 2 | 6 | ZAPPDØT | 1/t | Airplane velocity along Z earth axis |
| 2 | 7 | DFRPMD | rpm/t | Engine rpm rate-of-change |
| 2 | 8 | XSPDØT | 1/t | Ship velocity along X earth axis |
| 2 | 9 | ZSPDØT | 1/t | Ship velocity along Z earth axis |
| 2 | 10 | TSPDØT | rad/t | Ship pitch attitude rate-of-change |

| R ARRAY<br>SEGMENT | <br>ELEMENT | VARIABLE<br>NAME | UNITS | DESCRIPTION |
|---|---|---|---|---|
| 4 | 1 | UO | 1/t | Reference value of UB used for local linearization |
| 4 | 2 | WO | 1/t | Reference value of WB used for local linearization |
| 4 | 3 | QO | rad/t | Reference value of QB used for local linearization |
| 4 | 4 | THETAO | rad | Reference value of THETA used for local linearization |
| 4 | 5 | XAPPO | 1 | Reference value of XAPP used for local linearization |
| 4 | 6 | ZAPPO | 1 | Reference value of ZAPP used for local linearization |
| 4 | 7 | XO | $1/t^2$ | $\Sigma F_x$/mass |
| 4 | 8 | ZO | $1/t^2$ | $\Sigma F_z$/mass |
| 4 | 9 | MO | $rad/t^2$ | $\Sigma M_y/I_y$ |
| 4 | 10 | UBASO | 1/t | Reference value of UBAS |
| 4 | 11 | WBASO | 1/t | Reference value of WBAS |
| 4 | 12 | WASDO | $1/t^2$ | Reference value of WASD |
| 4 | 13 | THETAAO | rad | Reference value of THETAA |
| 4 | 14 | PSIAO | rad | Reference value of PSIA |
| 4 | 15 | PHIAO | rad | Reference value of PHIA |
| 4 | 16 | RCDO | 1/t | Reference value of RCD |
| 4 | 17 | VO | 1/t | Reference value of VB used for local linearization |
| 4 | 18 | PO | rad/t | Reference value of PB used for local linearization |
| 4 | 19 | RO | rad/t | Reference value of RB used for local linearization |

Cont'd

| R ARRAY | | VARIABLE | UNITS | DESCRIPTION |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME | | |
| 4 | 20 | YAPPO | 1 | Reference value of YAPP |
| 4 | 21 | PHIO | rad | Reference value of PHI |
| 4 | 22 | PSIO | rad | Reference value of PSI |
| 4 | 23 | YO | $1/t^2$ | $\Sigma F_y$/mass |
| 4 | 24 | LO | rad/$t^2$ | $\Sigma M_x'/I_x$ |
| 4 | 25 | NO | rad/$t^2$ | $\Sigma M_z'/I_z$ |
| 4 | 26 | VBASO | 1/t | Reference value of VBAS |

| R ARRAY | | VARIABLE | UNITS | DESCRIPTION |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME | | |
| 5 | 1 | SUMFXO | f | Initial summation of forces along the airplane body axis. Required input if means are propagated. |
| 5 | 2 | SUMFZO | f | Initial summation of forces along the airplane body axis. Required input if means are propagated. |
| 5 | 3 | SUMMO | fl | Initial summation of moments about the airplane body axis. Required input if means are propagated. |
| 5 | 4 | SUMFX | $1/t^2$ | Summation of 'forces' along airplane X body axis. |
| 5 | 5 | DFX | $1/t^2$ | Incremental 'force' due to airplane departure from reference trajectory. |
| 5 | 6 | SUMFZ | $1/t^2$ | Summation of 'forces' along airplane Z body axis. |
| 5 | 7 | DFZ | $1/t^2$ | Incremental 'force' due to airplane departure from reference trajectory. |
| 5 | 8 | SUMM | $rad/t^2$ | Summation of 'moments' about airplane Y body axis. |
| 5 | 9 | DM | $rad/t^2$ | Incremental pitching 'moment' due to airplane departure from reference trajectory. |
| 5 | 10 | SUMFYO | f | Initial summation of forces along the airplane Y body axis. Required input if means are propagated. |
| 5 | 11 | SUMLO | fl | Initial summation of moments about the airplane X body axis. Required input if means are propagated. |

Cont'd

| R ARRAY SEGMENT | ELEMENT | VARIABLE NAME | UNITS | DESCRIPTION |
|---|---|---|---|---|
| 5 | 12 | SUMNO | fl | Initial summation of moments about the airplane Z body axis. Required input if means are propagated. |
| 5 | 13 | SUMFY | $1/t^2$ | Summation of 'forces' along airplane Y body axis. |
| 5 | 14 | DFY | $1/t^2$ | Incremental 'force' due to airplane departure from reference trajectory. |
| 5 | 15 | SUML | $rad/t^2$ | Summation of 'moments' that produce angular acceleration only about the airplane X body axis. |
| 5 | 16 | DL | $rad/t^2$ | Incremental 'moment' due to airplane departure from reference trajectory. |
| 5 | 17 | SUMN | $rad/t^2$ | Summation of 'moments' that produce angular acceleration only about the airplane Z body axis. |
| 5 | 18 | DN | $rad/t^2$ | Incremental 'moment' due to airplane departure from reference trajectory. |

| R ARRAY | | VARIABLE | UNITS | DESCRIPTION |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME | | |
| 6 | 1 | WEIGHT | $ml/t^2$ | Airplane weight |
| 6 | 2 | G | $l/t^2$ | Gravitational constant |
| 6 | 3 | IX | $ml^2$ | Airplane body axis inertia component |
| 6 | 4 | IY | $ml^2$ | Airplane body axis inertia component |
| 6 | 5 | IZ | $ml^2$ | Airplane body axis inertia component |
| 6 | 6 | IXZ | $ml^2$ | Product of inertia |
| 6 | 7 | LM | $l$ | Overall length of ship |
| 6 | 8 | WM | $l$ | Maximum beam of ship |
| 6 | 9 | LTDM | $l$ | Distance from bow to landing pad center measured along ship centerline |
| 6 | 10 | LS | $l$ | Scaled ship length |
| 6 | 11 | LTDS | $l$ | A scaled LTDM |

| R ARRAY |  | VARIABLE |  |  |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME | UNITS | DESCRIPTION |
| 7 | 1 | ØMEGAU |  | WHITE NOISE $\longrightarrow \boxed{\frac{KU}{S + ØMEGAU}} \longrightarrow$ DRYDEN TURBULENCE ALONG AIRPLANE X BODY AXIS |
| 7 | 2 | ØMEGAW |  |  |
| 7 | 3 | KU |  | WHITE NOISE $\longrightarrow \boxed{\frac{KW}{S + ØMEGAW}} \longrightarrow$ DRYDEN TURBULENCE ALONG AIRPLANE Z BODY AXIS |
| 7 | 4 | KW |  |  |
| 7 | 5 | KFRPM |  | Gain on input to engine model |
| 7 | 6 | KCDN |  | Gain on input to nozzle actuator |
| 7 | 7 | TAUENG | t | Engine time constant |
| 7 | 8 | TAUCDN | t | Nozzle actuator time constant |
| 7 | 9 | TAUD | t | Nozzle actuator time constant |
| 7 | 10 | KDEU | 1/1 | Longitudinal optimal pilot feedback gains on states into pitch control |
| 7 | 11 | KDEW | 1/1 |  |
| 7 | 12 | KDEQ | 1/rad |  |
| 7 | 13 | KDET | $\frac{1}{t\ rad}$ |  |
| 7 | 14 | KDEX | $\frac{1}{t\ 1}$ |  |
| 7 | 15 | KDEZ | $\frac{1}{t\ 1}$ |  |
| 7 | 16 | KDEN | $\frac{1}{t\ rpm}$ |  |
| 7 | 17 | KDEDE | $\frac{1}{t}$ |  |
| 7 | 18 | KDEDT | $\frac{1}{t}$ |  |

Cont'd

| R ARRAY | | VARIABLE | UNITS | DESCRIPTION |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME | | |
| 7 | 19 | KDTU | 1/l | Longitudinal optimal pilot feedback gains on states into thrust control |
| 7 | 20 | KDTW | 1/l | |
| 7 | 21 | KDTQ | 1/rad | |
| 7 | 22 | KDTT | $\frac{1}{t\ rad}$ | |
| 7 | 23 | KDTX | $\frac{1}{t\ l}$ | |
| 7 | 24 | KDTZ | $\frac{1}{t\ l}$ | |
| 7 | 25 | KDTN | $\frac{1}{t\ rpm}$ | |
| 7 | 26 | KDTDE | $\frac{1}{t}$ | |
| 7 | 27 | KDTDT | 1/t | |
| 7 | 28 | ØMEGAV | | WHITE NOISE $\rightarrow \boxed{\frac{KV}{S + \O MEGAV}} \rightarrow$ DRYDEN TURBULENCE ALONG AIRPLANE Y BODY AXIS |
| 7 | 29 | KV | | |
| 7 | 30 | TAUA | t | Actuator time constant |
| 7 | 31 | K1 | | |
| 7 | 32 | K2 | | ROLL CONTROL: |
| 7 | 33 | KY | | ERPHI $\rightarrow \boxed{\frac{K1(TL1*S+B1)(-S+2/TAUD)}{(TAU*S+1)(S+2/TAUD)}} \rightarrow$ DAP |
| 7 | 34 | B1 | | |
| 7 | 35 | B2 | | YAW CONTROL: |
| 7 | 36 | TL1 | | ERPSI $\rightarrow \boxed{\frac{K2(TL2*S+B2)(-S+2/TAUD)}{(TAU*S+1)(S+2/TAUD)}} \rightarrow$ DRP |
| 7 | 37 | TL2 | | |

| R ARRAY |  | VARIABLE | UNITS | DESCRIPTION |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME |  |  |
| 8 | 1 | ALT | 1 | Altitude |
| 8 | 2 | VAIR | 1/t | Airspeed |
| 8 | 3 | UBAS | 1/t | Airplane X body axis component of airspeed |
| 8 | 4 | VBAS | 1/t | Airplane Y body axis component of airspeed |
| 8 | 5 | WBAS | 1/t | Airplane Z body axis component of airspeed |
| 8 | 6 | ALPHA | rad | Angle-of-attack |
| 8 | 7 | BETA | rad | Sideslip angle |
| 8 | 8 | DUM1 |  | Dummy variable, this location unused |
| 8 | 9 | DUM2 |  | Dummy variable, this location unused |
| 8 | 10 | V5 | 1/t | Ship speed |
| 8 | 11 | PSI5 | rad | Ship heading |
| 8 | 12 | X1DWS | 1/t | Earth axis component of ship's relative wind |
| 8 | 13 | Y1DWS | 1/t | Earth axis component of ship's relative wind |
| 8 | 14 | VAMB | 1/t | Ambient wind speed |
| 8 | 15 | PSIAMB | rad | Ambient wind heading |
| 8 | 16 | X1DWA | 1/t | Earth axis component of ambient wind |
| 8 | 17 | Y1DWA | 1/t | Earth axis component of ambient wind |
| 8 | 18 | Z1DWA | 1/t | Earth axis component of ambient wind |

Cont'd

| SEGMENT | R ARRAY<br>ELEMENT | VARIABLE<br>NAME | UNITS | DESCRIPTION |
|---|---|---|---|---|
| 8 | 19 | VWØD | l/t | Wind-over-deck speed |
| 8 | 20 | PSIWØD | rad | Wind-over-deck heading |
| 8 | 21 | PSI3 | rad | Orientation of ship wing axis; angle of rotation about the Z earth axis to point ship X wind axis into the wind-over-deck |
| 8 | 22 | PSISP | rad | = PSI3 - PSI5 |
| 8 | 23 | PSIS | rad | = -PSIP; this is the angle $\psi_{ss}$ in the airwake math model of Reference 12 |
| 8 | 24 | DX45 | l | Earth axis distance between airplane and ship |
| 8 | 25 | DY45 | l | Earth axis distance between airplane and ship |
| 8 | 26 | DZ45 | l | Earth axis distance between airplane and ship |
| 8 | 27 | XM | l | Airplane position in space with respect to the ship wind axis system (i.e., the airwake model reference point) |
| 8 | 28 | YM | l | |
| 8 | 29 | ZM | l | |
| 8 | 30 | PSIA | rad | Euler type angles relating the airplane to the ship wind axis system. It is assumed that the ship wind axis does not pitch and/or roll. |
| 8 | 31 | THETAA | rad | |
| 8 | 32 | PHIA | rad | |
| 8 | 33 | SIGMAVX | l/t | Standard deviations of the airwake in the ship wind axis system |
| 8 | 34 | SIGMAVY | l/t | |
| 8 | 35 | SIGMAVZ | l/t | |
| 8 | 36 | VXAW | l/t | Mean components of the ship airwake in the ship wind axis system |
| 8 | 37 | VYAW | l/t | |
| 8 | 38 | VZAW | l/t | |

Cont'd

| R ARRAY<br>SEGMENT | <br>ELEMENT | VARIABLE<br>NAME | UNITS | DESCRIPTION |
|---|---|---|---|---|
| 8 | 39 | UWIND | 1/t | Total wind component along airplane X body axis;<br>UWIND = UMEAN + UAW |
| 8 | 40 | UMEAN | 1/t | Ambient wind component along airplane X body axis |
| 8 | 41 | UR | | Random wind component; unused |
| 8 | 42 | UAW | 1/t | Mean component of airwake disturbance along airplane X body axis |
| 8 | 43 | VWIND | 1/t | Total wind component along airplane Y body axis;<br>VWIND = VMEAN + VAW |
| 8 | 44 | VMEAN | 1/t | Ambient wind component along airplane Y body axis |
| 8 | 45 | VR | | Random wind component; unused |
| 8 | 46 | VAW | 1/t | Mean component of airwake disturbance along airplane Y body axis |
| 8 | 47 | WWIND | 1/t | Total wind component along airplane Z body axis;<br>WWIND = WMEAN + WAW |
| 8 | 48 | WMEAN | 1/t | Ambient wind component along airplane Z body axis |
| 8 | 49 | WR | | Random wind component; unused |
| 8 | 50 | WAW | 1/t | Mean component of airwake disturbance along airplane Z body axis |
| 8 | 51 | WNSF | rad/t | Natural frequency of second order shaping filter used in airwake model |
| 8 | 52 | PSISS | | sin (PSIS) |

Cont'd

| R ARRAY | | VARIABLE | UNITS | DESCRIPTION |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME | | |
| 8 | 53 | PSISC | | cos (PSIS) |
| 8 | 54 | PSIST | | tan (PSIS) |
| 8 | 55 | TS1 | | Temporary storage for preliminary calculations involving wind-over-deck and airwake shaping functions |
| 8 | 56 | TS2 | | |
| 8 | 57 | TS3 | | |
| 8 | 58 | TS4 | | |
| 8 | 59 | TS5 | | |
| 8 | 60 | TR1 | | Scale factor on SIGMAVX, SIGMAVY, and SIGMAVZ |
| 8 | 61 | DXM145 | | = cos (PSISP)* cox (PSI5) - sin (PSIP)* sin (PSI5) |
| 8 | 62 | DXM245 | | = cos (PSIP)* sin (PSI5) + sin (PSIP)* cos (PSI5) |
| 8 | 63 | DYM145 | | = -sin (PSIP)* cos (PSI5) - cox (PSIP)* sin (PSI5) |
| 8 | 64 | DYM245 | | = cos (PSIP)* cos (PSI5) - sin (PSIP)* sin (PSI5) |
| 8 | 65 | ZGSP | 1 | Commanded $Z'_{A/P}$ |
| 8 | 66 | ZBIASP | 1 | Bias term |

| R ARRAY | | VARIABLE | UNITS | DESCRIPTION |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME | | |
| 9 | 1 | THETAC | rad | Commanded airplane pitch attitude |
| 9 | 2 | DFRPMØL | rpm | Open loop rpm command |
| 9 | 3 | DCDNØL | rad | Open loop nozzle command |
| 9 | 4 | DEØL | units | Open loop pitch control command |
| 9 | 5 | GAMMAGS | deg | Commanded glide slope angle |
| 9 | 6 | RANGE | 1 | $\triangleq X'_S - X'_{A/P}$ |
| 9 | 7 | VAIRC | 1/t | Commanded airspeed |
| 9 | 8 | DAØL | units | Open loop roll control command |
| 9 | 9 | DRØL | units | Open loop yaw control command |

| R ARRAY<br>SEGMENT | ELEMENT | VARIABLE<br>NAME | UNITS | DESCRIPTION |
|---|---|---|---|---|
| 10 | 1 | XU | 1/t | Airplane longitudinal dimensional derivatives; results of table look up |
| 10 | 2 | XW | 1/t | |
| 10 | 3 | XQ | 1/t | |
| 10 | 4 | XFRPM | $\frac{1}{t^2 * rpm}$ | |
| 10 | 5 | XCDN | $\frac{1}{t^2}$ | |
| 10 | 6 | XPDIGV | | Not used |
| 10 | 7 | XDE | $1/t^2$ | |
| 10 | 8 | ZU | 1/t | |
| 10 | 9 | ZW | 1/t | |
| 10 | 10 | ZQ | 1/t | |
| 10 | 11 | ZFRPM | $\frac{1}{t^2 * rpm}$ | |
| 10 | 12 | ZCDN | $\frac{1}{t^2}$ | |
| 10 | 13 | ZPDIGV | | Not used |
| 10 | 14 | ZDE | $1/t^2$ | |
| 10 | 15 | MU | $\frac{1}{1\ t}$ | |
| 10 | 16 | MW | $\frac{1}{1\ t}$ | |
| 10 | 17 | MWDØT | $\frac{1}{1}$ | |
| 10 | 18 | MQ | $\frac{1}{t}$ | |
| 10 | 19 | MFRPM | $\frac{1}{t^2 * rpm}$ | |
| 10 | 20 | MCDN | $\frac{1}{t^2}$ | |

Cont'd

| R ARRAY | | VARIABLE | UNITS | DESCRIPTION |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME | | |
| 10 | 21 | MPDIGV | | Not used |
| 10 | 22 | MDE | $1/t^2$ | |
| 10 | 23 | YV | $1/t$ | Airplane lateral/directional dimensional derivatives; results of table look up |
| 10 | 24 | YP | $1/t$ | |
| 10 | 25 | YR | $1/t$ | |
| 10 | 26 | YDA | $1/t^2$ | |
| 10 | 27 | YDR | $1/t$ | |
| 10 | 28 | LV | $\frac{1}{l\ t}$ | |
| 10 | 29 | LP | $\frac{1}{t}$ | |
| 10 | 30 | LR | $1/t$ | |
| 10 | 31 | LDA | $\frac{rad}{t^2}$ | |
| 10 | 32 | LDR | $\frac{rad}{t^2}$ | |
| 10 | 33 | NV | $\frac{1}{l\ t}$ | |
| 10 | 34 | NP | $\frac{1}{t}$ | |
| 10 | 35 | NR | $\frac{1}{t}$ | |
| 10 | 36 | NDA | $\frac{rad}{t^2}$ | |
| 10 | 37 | NDR | $\frac{rad}{t^2}$ | |

| R ARRAY | | VARIABLE | UNITS | DESCRIPTION |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME | | |
| 11 | 1 | RC | 1 | Commanded range;<br>range $\triangleq X'_S - X'_{A/P}$ |
| 11 | 2 | RCD | 1/t | Commanded range time rate-of-change |
| 11 | 3 | XAPCØM | 1 | Airplane commanded position along X earth axis |
| 11 | 4 | ERRX | 1 | $= X'_{A/P}$ - XAPCØM; longitudinal position error |
| 11 | 5 | ERRU | 1/t | Airplane body axis component of error rate |
| 11 | 6 | ERRZ | 1 | $= Z'_{A/P}$ - ZGSP; vertical position error |
| 11 | 7 | ERRW | 1/t | Airplane body axis component of error rate |
| 11 | 8 | ETHETA | rad | = THETA - THETAC; pitch altitude error |
| 11 | 9 | ERY | 1 | = YCØM - $Y'_{A/P}$; lateral position error |
| 11 | 10 | ERPHI | rad | = PHICØM - PHI; roll altitude error |
| 11 | 11 | ERPSI | rad | = PSICØM - PSI; heading error |
| 11 | 12 | YCØM | 1 | Airplane commanded Y earth axis position |
| 11 | 13 | PHICØM | rad | Airplane roll altitude command |
| 11 | 14 | PSICØM | rad | Airplane heading command |

| R ARRAY SEGMENT | R ARRAY ELEMENT | VARIABLE NAME | UNITS | DESCRIPTION |
|---|---|---|---|---|
| 12 | 1 | DE | units | Pitch control displacemert |
| 12 | 2 | DT | units | Thrust control displacement |
| 12 | 3 | DCDN | rad | Nozzle position |
| 12 | 4 | DED | 1/t | Pitch control rate |
| 12 | 5 | DTD | 1/t | Thrust control rate |
| 12 | 6 | DCDND | rad/t | Nozzle angle rate |
| 12 | 7 | DA | units | Roll control displacement limited output value |
| 12 | 8 | DR | units | Yaw control displacement limited output value |
| 12 | 9 | DAP | units | Roll control displacement, input to limiter |
| 12 | 10 | DRP | units | Yaw control displacement, input to limiter |
| 12 | 11 | DA1 | units | Intermediate variable used in calculation of roll control |
| 12 | 12 | DA2 | units | Intermediate variable used in calculation of roll control |
| 12 | 13 | DR1 | units | Intermediate variable used in calculation of yaw control |
| 12 | 14 | DR2 | units | Intermediate variable used in calculation of yaw control |
| 12 | 15 | DA1D | 1/t | Intermediate rate variable used in calculation of roll control |
| 12 | 16 | DA2D | 1/t | Intermediate rate variable used in calculation of roll control |
| 12 | 17 | DR1D | 1/t | Intermediate rate variable used in calculation of yaw control |
| 12 | 18 | DR2D | 1/t | Intermediate rate variable used in calculation of yaw control |

| SEGMENT | R ARRAY<br>ELEMENT | VARIABLE<br>NAME | UNITS | DESCRIPTION |
|---|---|---|---|---|
| 13 | 1-6 | TABV1 | 1/t | Independent variable table of airspeeds |
| 14 | 1-10 | TABV2 | t | Independent variable table of time |

| R ARRAY | | VARIABLE | UNITS | DESCRIPTION |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME | | |
| 16 | 1 | SIGDAP | units | Standard deviation of roll control displacement at input to limiter |
| 16 | 2 | SIGDRP | units | Standard deviation of yaw control displacement at input to limiter |
| 16 | 3 | SIGDA | units | Standard deviation of roll control displacement after limiter |
| 16 | 4 | SIGDR | units | Standard deviation of yaw control displacement after limiter |
| 16 | 5 | GAINDA | | Gain on random component of roll control, from describing function representation of limiter |
| 16 | 6 | GAINDR | | Gain on random component of yaw control, from describing function representation of limiter |

| R ARRAY |  | VARIABLE | UNITS | DESCRIPTION |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME |  |  |
| 17 | 1 | KXS | 1 | Gains, damping ratios, and natural frequency for the transfer functions which describe ship surge, heave, pitch, sway, roll, and yaw perturbations |
| 17 | 2 | ZETAXS |  |  |
| 17 | 3 | WNXS | rad/t |  |
| 17 | 4 | KZS | 1 |  |
| 17 | 5 | ZETAZS |  |  |
| 17 | 6 | WNZS | rad/t |  |
| 17 | 7 | KTS | rad |  |
| 17 | 8 | ZETATS |  |  |
| 17 | 9 | WNTS | rad/t |  |
| 17 | 10 | KYS | 1 |  |
| 17 | 11 | ZETAYS |  |  |
| 17 | 12 | WNYS | rad/t |  |
| 17 | 13 | KRS | rad |  |
| 17 | 14 | ZETARS |  |  |
| 17 | 15 | WNRS | rad/t |  |
| 17 | 16 | KPS | rad |  |
| 17 | 17 | ZETAPS |  |  |
| 17 | 18 | WNPS | rad/t |  |
| 17 | 19 | TAUPRT | t | Time constant of first order lag. Output of this filter modifies pilots altitude command. |

| R ARRAY | | VARIABLE | UNITS | DESCRIPTION |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME | | |
| 18 | None | N/A | N/A | Open segment |
| 19 | None | N/A | N/A | Open segment |
| 20 | 1-10 | TABTC | rad | Dependent variable table of pitch altitude commands |
| 21 | 1-10 | TRPMØL | rpm | Dependent variable table of rpm open loop inputs |
| 22 | 1-10 | TCDNØL | deg | Dependent variable table of nozzle position open loop inputs |
| 23 | 1-10 | TDEØL | units | Dependent variable table of pitch control open loop inputs |
| 24 | 1-10 | TABR | | Dependent variable table of range commands; not currently in use |
| 25 | 1-10 | TABRDØT | | Dependent variable table of rate-of-closure; not currently in use |
| 27 | 1-6 | TXU | | Dependent variable tables of longitudinal dimensional derivatives. Units are consistent with output values |
| 28 | 1-6 | TXW | | |
| 29 | 1-6 | TXQ | | |
| 30 | 1-6 | TXRPM | | |
| 31 | 1-6 | TXCDN | | |
| 32 | 1-6 | TXPIGV | | |
| 33 | 1-6 | TXDE | | |
| 34 | 1-6 | TZU | | |
| 35 | 1-6 | TZW | | |

Cont'd

| R ARRAY | | VARIABLE | UNITS | DESCRIPTION |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME | | |
| 36 | 1-6 | TZQ | | |
| 37 | 1-6 | TZRPM | | |
| 38 | 1-6 | TZCDN | | |
| 39 | 1-6 | TZPIGV | | |
| 40 | 1-6 | TZDE | | |
| 41 | 1-6 | TMU | | |
| 42 | 1-6 | TMW | | |
| 43 | 1-6 | TMWD | | |
| 44 | 1-6 | TMQ | | |
| 45 | 1-6 | TMRPM | | |
| 46 | 1-6 | TMCON | | |
| 47 | 1-6 | TMPIGV | | |
| 48 | 1-6 | TMDE | | |
| 49 | None | None | N/A | Open segment |

| R ARRAY |  | VARIABLE |  |  |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME | UNITS | DESCRIPTION |
| 50 | varies | F |  | Overall system matrix |
| 51 | varies | P |  | Covariance matrix |
| 52 | varies | PDØT |  | Covariance matrix time rate-of-change; PDØT=F*P + P*$F^T$ + GM*QM*$GM^T$ |
| 53 | varies | GM |  | Matrix relating external white noise disturbances to state equations |
| 54 | varies | QM |  | Covariance matrix of external white noise sources |
| 55 | 1-50 | SIGMA | varies | Array of standard deviations |
| 56 | 1-50 | SIGMAXY | varies | Array of cross correlations with a given element (used when plotting ellipses); see subroutine MISCAL |
| 57 | 1-75 | VXX | 1/t | Table of mean components of airwake along x ship wind axis |
| 58 | 1-75 | VYY | 1/t | Table of mean components of airwake along y ship wind axis |
| 59 | 1-75 | VZZ | 1/t | Table of mean component of airwake along z ship wind axis |
| 60 | 1-75 | SVXX | 1/t | Table of standard deviation components of airwake along X ship wind axis |
| 61 | 1-75 | SVYY | 1/t | Table of standard deviation components of airwake along Y ship wind axis |
| 62 | 1-75 | SVZZ | 1/t | Table of standard deviation components along Z ship wind axis |

| R ARRAY | | VARIABLE | | |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME | UNITS | DESCRIPTION |
| 63 | 1-6 | TKDEU | | Dependent variable tables of pilot feedback gains. Units are consistent with previously defined output values. |
| 64 | 1-6 | TKDEW | | |
| 65 | 1-6 | TKDEQ | | |
| 66 | 1-6 | TKDET | | |
| 67 | 1-6 | TKDEX | | |
| 68 | 1-6 | TKDEZ | | |
| 69 | 1-6 | TKDEN | | |
| 70 | 1-6 | TKDEDE | | |
| 71 | 1-6 | TKDEDT | | |
| 72 | 1-6 | TKDTU | | |
| 73 | 1-6 | TKDTW | | |
| 74 | 1-6 | TKDTQ | | |
| 75 | 1-6 | TKDTT | | |
| 76 | 1-6 | TKDTX | | |
| 77 | 1-6 | TKDTZ | | |
| 78 | 1-6 | TKDTN | | |
| 79 | 1-6 | TKDTDE | | |
| 80 | 1-6 | TKDTDT | | |
| 81 | varies | F1 | | Aircraft system matrix |
| 82 | varies | G1 | | Aircraft control matrix |
| 83 | varies | GAMMA | | Matrix relating colored noise inputs to aircraft |

Cont'd

| R ARRAY |  | VARIABLE | UNITS | DESCRIPTION |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME |  |  |
| 84 | varies | A |  | Colored noise shaping matrix |
| 85 | varies | B |  | Matrix relating white noise inputs to shaping filters |
| 86 | varies | M1 |  | Not currently used |
| 87 | varies | M2 |  | Not currently used |
| 88 | varies | H |  | Not currently used |
| 89 | varies | D |  | Measurement matrix |
| 90 | varies | C |  | Feedback matrix operating on states in control rate equation |
| 91 | varies | RL |  | Feedback matrix operating on controls in control rate equation |
| 92 | varies | W |  | Covariance matrix of white noise external disturbances |
| 93 | varies | VU |  | Covariance matrix of white neuromuscular noise |
| 94 | varies | VY |  | Covariance matrix of white measurement noise |
| 95 | varies | VYI |  | Inverse of matrix VY |
| 96 | varies | S |  | Ship motion system matrix |
| 97 | varies | FE |  | System matrix for estimator covariance calculation |
| 98 | varies | QE |  | Covariance matrix for driving estimator covariance calculation |
| 99 | varies | PE |  | Covariance matrix for estimator error |
| 100 | varies | PED |  | Time rate-of-change of estimator error covariance matrix |
| 101 | varies | KG |  | Kalman gain matrix |

Cont'd

| SEGMENT | R ARRAY<br>ELEMENT | VARIABLE<br>NAME | UNITS | DESCRIPTION |
|---|---|---|---|---|
| 102 | varies | FXHAT | | System matrix for estimated state covariance calculations |
| 103 | varies | PXHAT | | Estimated states covariance matrix |
| 104 | varies | PXHATD | | Time rate-of-change of estimated states covariance matrix |
| 105 | varies | PX | | State covariance matrix |
| 106 | varies | CS | | A sub matrix in F related to the modified pilot altitude command due to ship motion |

| R ARRAY | | VARIABLE | UNITS | DESCRIPTION |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME | | |
| 107 | 1 | DEUR | $\frac{1}{T}$ | These additional feedback gains in the optimal pilot model operate on the estimated colored noise disturbances; results of table look-up |
| 107 | 2 | DEWR | $\frac{1}{T}$ | |
| 107 | 3 | DEVX | $\frac{1}{T}$ | |
| 107 | 4 | DEVXD | $\frac{t}{T}$ | |
| 107 | 5 | DEVZ | $\frac{1}{T}$ | |
| 107 | 6 | DEVZD | $\frac{t}{T}$ | |
| 107 | 7 | DTUR | $\frac{1}{T}$ | |
| 107 | 8 | DTWR | $\frac{1}{T}$ | |
| 107 | 9 | DTVX | $\frac{1}{T}$ | |
| 107 | 10 | DTVXD | $\frac{t}{T}$ | |
| 107 | 11 | DTVZ | $\frac{1}{T}$ | |
| 107 | 12 | DTVZD | $\frac{t}{T}$ | |

| R ARRAY | | VARIABLE | UNITS | DESCRIPTION |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME | | |
| 108 | 1-6 | TDEUR | | Dependent variable tables for pilot feedback gains. Units are consistent with the output values. |
| 109 | 1-6 | TDEWR | | |
| 110 | 1-6 | TDEVX | | |
| 111 | 1-6 | TDEVXD | | |
| 112 | 1-6 | TDEVZ | | |
| 113 | 1-6 | TDEVZD | | |
| 114 | 1-6 | TDTUR | | |
| 115 | 1-6 | TDTWR | | |
| 116 | 1-6 | TDTVX | | |
| 117 | 1-6 | TDTVXD | | |
| 118 | 1-6 | TDTVZ | | |
| 119 | 1-6 | TDTVZD | | |
| 120 | 1-6 | TYV | | Dependent variable tables for lateral/directional dimensional derivatives. Units are consistent with output values. |
| 121 | 1-6 | TYP | | |
| 122 | 1-6 | TYR | | |
| 123 | 1-6 | TYDA | | |
| 124 | 1-6 | TYDR | | |
| 125 | 1-6 | TLV | | |
| 126 | 1-6 | TLP | | |
| 127 | 1-6 | TLR | | |

Cont'd

| R ARRAY | | VARIABLE | UNITS | DESCRIPTION |
|---|---|---|---|---|
| SEGMENT | ELEMENT | NAME | | |
| 128 | 1-6 | TLDA | | ↓ |
| 129 | 1-6 | TLDR | | |
| 130 | 1-6 | TNV | | |
| 131 | 1-6 | TNP | | |
| 132 | 1-6 | TNR | | |
| 133 | 1-6 | TNDA | | |
| 134 | 1-6 | TNDR | | |
| 135 | 1-10 | TABUB | 1/t | Dependent variable tables of longitudinal parameters required in a lateral/directional run. |
| 136 | 1-10 | TABWB | 1/t | ↓ |
| 137 | 1-10 | TXAPP | 1 | |
| 138 | 1-10 | TZAPP | 1 | |
| 139 | 1-10 | TXSP | 1 | |
| 140 | 1-4 | TDAIN | units | Independent variable table for defining roll control limiter. |
| 141 | 1-4 | TDAØUT | units | Dependent variable table for defining roll control limiter. |
| 142 | 1-4 | TDRIN | units | Independent variable table for defining yaw control limiter. |
| 143 | 1-4 | TDRØUT | units | Dependent variable table for defining yaw control limiter. |

# APPENDIX F

# LIST OF SYMBOLS

## F.0 LIST OF SYMBOLS

Throughout the text several equations appear in vector-matrix format. In these equations lower case letters represent vectors and upper case letters are matrices. For scalar quantities, upper case letters are nominal or mean values and lower case letters represent perturbation values. The test clearly distinguishes between variables, as to whether they are matrices, vectors, or scalars, when they are used.

Symbols

| | |
|---|---|
| $C_i$ | Dimensional stability derivative (includes mass or inertia);<br>$C = X, Y, Z, L, M,$ and $N$;<br>$i = u, v, w, p, q, r,$ and $\delta_j$. |
| $E\{\ \}$ | Expected value operator. |
| $g$ | Gravitational constant. |
| $s$ | Laplace transform variable. |
| $X'_{A/P}$, $Y'_{A/P}$, $Z'_{A/P}$ | Earth axis coordinates of the airplane. |
| $X'_s$, $Y'_s$, $Z'_s$ | Earth axis coordinates of the ship. |
| W.O.D. | Wind over deck |
| T/W | Thrust to weight ratio |
| $\delta_j$ | Deflection of $j^{\underline{th}}$ controller. |
| $\delta_{ES}$ | AV-8 pitch control position. |
| $\delta_T$ | AV-8 throttle position. |
| $\delta_j$ | AV-8 nozzle angle. |
| $\delta_{as}$ | AV-8 roll control position |
| $\delta_{RP}$ | AV-8 yaw control position |

| | |
|---|---|
| $\sigma$ | Standard deviation. |
| $\psi$, $\Theta$, $\phi$ | Euler angles. |
| $(\dot{\ })$ | Time derivative of ( ). |
| $(\bar{\ })$ | Mean value of ( ). |
| $(\hat{\ })$ | Expected value of ( ). |

Subscripts

| | |
|---|---|
| o | Denotes reference value or condition. |
| g | Gust. |

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